MacTCP Administrator's Guide

Version 2.0

Apple Computer, Inc.

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Contents

Preface About This Guide / ix

Intended audience / ix
How to use this guide / x
Conventions / x
Associated documents / xi
Books / xi
Request for Comments (RFC) / xii
Military standards / xii

Part 1 Concepts / 1

1 About the MacTCP Driver / 3

Overview / 4
System requirements / 5
Network environment / 6
DDP-IP gateway / 7

2 About TCP/IP / 9

The family of protocols / 10
Internet Protocol (IP) / 12
Transmission Control Protocol (TCP) / 12
User Datagram Protocol (UDP) / 13

Telnet / 13
File Transfer Protocol (FTP) / 13
Simple Mail Transfer Protocol (SMTP) / 14
Simple Network Management Protocol (SNMP) / 14

3 TCP/IP Addressing Conventions / 15

Internet addresses / 16
Subnetwork addressing / 17
Subnetwork masks / 19
The domain name system / 19
Address Resolution Protocol (ARP) / 21
Reverse Address Resolution Protocol (RARP) / 22
Bootstrap Protocol (BootP) / 23

4 Routing / 25

Gateways / 26
Routing tables / 27
Routing protocols / 27
Routing Information Protocol (RIP) / 27
Internet Control Message Protocol (ICMP) / 28

Part 2 Procedures / 29

5 Configuring MacTCP / 31

The MacTCP Admin and MacTCP files / 32
Configuration tools in MacTCP Admin / 32
The MacTCP control panel / 32
The Administrator dialog box / 33
Obtain Address box / 34
IP Address box / 34
Routing Information box / 34
Domain Name Server Information box / 35
Protected checkbox / 35
Configuration scenarios / 35

Opening the MacTCP control panel / 38
Version 7.*x* environment / 38
Version 6.0.*x* environment / 39
Setting link level information / 40
Network configuration 1 / 41
Network configuration 2 / 42
Network configuration 3 / 43
Network configuration 4 / 44
Network configuration 5 / 46
Adjusting the MTU size / 48
Setting the IP address in decimal notation / 50
Opening the Administrator dialog box / 51
Setting the IP address / 52
Setting the address manually / 53
Setting the IP address class / 53
Setting the subnet mask / 55
Setting the IP address (integer format) / 55
Obtaining an address from a server / 57
Setting the node number dynamically / 58
Setting the gateway address / 59
Setting domain name server information / 59
Domain Name Resolver (DNR) operation / 60
Protecting the configuration / 61
Giving the user full configuration power / 61
Closing the control panel / 62
What to do next / 62

6 Distributing the TCP/IP Connection Software / 63

Before you distribute the software / 64
The MacTCP Prep configuration rules / 64
Giving the MacSNMP Client application to the user / 64
User documentation / 65
Distribution media / 65
Distributing MacTCP only—any media / 66
Distributing a MacTCP startup disk—version 6.0.*x* only / 67
Distributing the TCP/IP Connection software on floppy disks / 68
Distributing the TCP/IP Connection software over the network / 69

Part 3 Appendixes / 71

Appendix A Name-to-Address Mapping / 73

Hosts file syntax / 74
Editing the Hosts file / 75

Appendix B Troubleshooting / 77

Duplicate address notification / 78
MacTCP Ping / 78
MacTCP Ping menus / 79
File / 79
Edit / 79
Options / 79
MacTCP Ping Information dialog box / 80
Ping Host Address / 80
Send ASCII/Hex Data / 80
Packet Data Size / 80
Send a packet every # ticks / 81
Display / 81
Start Ping / 81
Stop Ping / 81
Information and statistics area / 81

Glossary / 83

Index / 87

Figures and Tables

Figure 1-1 A MacTCP network configuration / 6
Figure 2-1 An internet / 10
Figure 2-2 A comparison of OSI and TCP/IP / 11
Figure 3-1 An IP address structure / 17
Figure 3-2 Subnetting at Pundit University / 18
Figure 4-1 Gateways connecting networks / 26
Figure 5-1 A view of the MacTCP control panel in version 6.0.*x* / 33
Figure 5-2 A view of the MacTCP Admin panel, the MacTCP control panel in version 7.*x* / 33
Figure 5-3 A view of the Administrator dialog box / 33
Figure 5-4 A road map to configuration scenarios / 37
Figure 5-5 Multiple Token Ring cards in a Macintosh II computer, as seen in the Token Ring and MacTCP control panels / 47
Figure 5-6 Physical slot numbers (shaded) and NuBus slot numbers in various Macintosh computers / 48

Table 3-1 The top-level domains / 20

Preface About This Guide

This guide describes the MacTCP driver, Apple Computer's implementation of the protocol suite known as Transmission Control Protocol/Internet Protocol (TCP/IP). It contains theoretical information about the protocol suite as well as instructions for configuring MacTCP. This guide is one of four documents that you received with your TCP/IP Administration product:

- *TCP/IP Administration: Overview and Installation*
- *MacTCP Administrator's Guide*
- *MacSNMP Administrator's Guide*
- *TCP/IP Connection User's Guide*

The *TCP/IP Administration: Overview and Installation* guide describes how to install the MacTCP software, then directs you to this manual for instructions on configuring the software for your computer and for some or all of your users.

Intended audience

This guide is intended for the network administrator who is responsible for network configuration. You should be familiar with Macintosh computer operations and general networking concepts. However, it is not necessary to be a TCP/IP expert; Part 1 of this guide provides conceptual information if you need to learn more about TCP/IP.

The major part of administering a MacTCP network involves using the MacTCP Admin control panel to configure MacTCP for network users. Before you start, you must determine how much you want network users involved in the configuration process; for instance, you can set up the control panel so that the user must enter all the configuration information or none of it. See the section "Configuration Scenarios" in Chapter 5 for more information.

How to use this guide

This guide begins with basic concepts in Part 1 and proceeds to explicit instructions in Part 2.

It is important to understand TCP/IP concepts, such as IP addressing, to configure the system correctly. To learn these basics, read the chapters in Part 1. If you are already familiar with TCP/IP, you may decide to move quickly to Part 2.

Part 2 describes how you, as a network administrator, configure the MacTCP driver and then distribute the TCP/IP Connection software to network users who in turn install and configure the software for their individual machines.

Conventions

The following conventions are used in this guide:

- 6.0.*x* refers to system software version 6.0.5 or later, but not version 7.0.
- 7.*x* refers to system software version 7.0 or later.

◆ **Note** Text set off in this manner presents sidelights or interesting points of information. ◆

△ **Important** Text set off in this manner—with the word *Important*—presents information that you must consider as you read the surrounding text. △

Associated documents

For additional information about MacTCP networks, see the *MacTCP Programmer's Guide*. This guide is for third-party developers creating application programs for the MacTCP driver. The *MacTCP Programmer's Guide* is available from APDA. That address is

APDA
Apple Computer, Inc.
P.O. Box 319
Buffalo, NY 14207-0319 U.S.A.
800-282-2732 (United States)
800-637-0029 (Canada)
716-871-6555 (International)
Fax: 716-871-65111
AppleLink: APDA
CompuServe: 76666,2405
Internet: APDA@applelink.apple.com

You might also find it useful to refer to *Inside AppleTalk, Second Edition* for a complete description of the AppleTalk network system.

Books

The following books provide information on TCP/IP:

- *An Introduction to TCP/IP,* by John Davidson, Springer-Verlag.
- *Handbook of Computer-Communication Standards, Volume 3: Department of Defense (DOD) Protocol Standards,* by William Stallings, Macmillan Publishing Company.
- *Internetworking With TCP/IP—Principles, Protocols, and Architecture, Second Edition,* by Douglas Comer, Prentice-Hall.

Request for Comments (RFC)

Request for Comments (RFC) is a series of technical notes used by the Internet community that contains reports of work, proposals, and protocol specifications. Important RFCs include 768 (UDP), 791 (IP), 792 (ICMP), 793 (TCP), 826 (ARP), 903 (RARP), and 951 (BootP). RFCs 999, 1000, and 1012 provide a guide to RFCs. RFC 1011 lists the official protocols.

RFCs are available from the DDN Network Information Center (NIC) at SRI International. That address is

DDN Network Information Center
SRI International, Room EJ 291
333 Ravenswood Avenue
Menlo Park, CA 94025

You can order hard copies of RFCs by calling 415-859-3695. To obtain an RFC electronically over the Internet, use anonymous FTP from the <RFC> directory on host SRI-NIC.ARPA. If you are outside the Internet and don't have access to FTP, you can receive RFCs by sending electronic mail to SERVICE@SRI-NIC.ARPA. Put the RFC number in the "Subject:" field.

The DDN NIC publishes the *DDN Protocol Handbook,* which contains most important RFCs related to TCP/IP.

Military standards

The Internet Protocol (IP), Transmission Control Protocol (TCP), File Transfer Protocol (FTP), Telnet, and Mail are described in the five Military Standards (MIL-STD) about TCP/IP protocols. These standards contain errors; when there are discrepancies between MIL-STDs and RFCs, RFCs always take precedence. You can obtain MIL-STDs from

Defense Printing Service Detachment Office
Building 4D
700 Robbins Avenue
Philadelphia, PA 19111-5094
Fax: 215-697-2978

Part 1 Concepts

1 About the MacTCP Driver

The MacTCP driver, Apple Computer's TCP/IP product, increases the Macintosh computer's ability to operate in a heterogeneous computer environment. MacTCP software allows the Macintosh computer to communicate with such diverse systems as IBM, DEC™, Sun, and Hewlett-Packard computers. This chapter describes the features and operation of the MacTCP driver.

Overview

The MacTCP driver is a software driver for the Macintosh Operating System that implements the following TCP/IP protocols:

- Internet Protocol (IP)
- Internet Control Message Protocol (ICMP)
- User Datagram Protocol (UDP)
- Address Resolution Protocol (ARP)
- Reverse Address Resolution Protocol (RARP)
- Routing Information Protocol (RIP)
- Bootstrap Protocol (BootP)
- Transmission Control Protocol (TCP)

These protocols provide core transmission services that third-party products use such as electronic mail, remote login, file transfer, remote printing, database access, and network management. Chapters 2, 3, and 4 describe these protocols and the services they provide.

The MacTCP driver conforms to Internet Request for Comments (RFC) and Military Standards (MIL-STD), ensuring interoperability with systems on the internets operated by local and regional network providers.

The network administrator uses the MacTCP Admin control panel to configure the MacTCP driver, thus simplifying installation and setup procedures. Chapter 5 of this guide describes how to use the MacTCP Admin control panel to configure the driver.

The MacTCP driver includes these features:

- A driver-level interface that allows the implementation of application protocols such as the File Transfer Protocol (FTP), SNMP, and Telnet.
- A domain name resolver that maps domain names to internet addresses. The domain name resolver is compatible with domain name server implementations that comply with RFC 1034 and 1035.
- A dialog box notification of the occurrence of a duplicate address.

System requirements

To use the TCP/IP Connection product, you need the following hardware and software:

- On a LocalTalk network, you need a Macintosh Plus computer or later model connected to the LocalTalk cable.
- On an Ethernet network, you need a Macintosh Plus computer or later model with an Ethernet connection such as the EtherTalk NB Card, Ethernet NB Card, a built-in Ethernet interface, or a third-party Ethernet device. Apple Ethernet connections require EtherTalk software version 2.5 or later. Third-party Ethernet devices must be compatible with the MacTCP driver.
- On a Token Ring network, you need a Macintosh computer that uses the NuBus™ expansion slot architecture, such as one of the Macintosh II family of computers, and an appropriate networking card, such as the TokenTalk NB Card, the Token Ring 4/16 NB Card, or a third-party Token Ring card that supports the .TOKN interface specification. Apple Token Ring connections also require TokenTalk Phase 2 and TokenTalk Prep software, version 2.5 or later (the software for the Token Ring card) and the MacTCP Token Ring Extension software contained in this product. Third-party Token Ring cards must be compatible with Apple Computer's MacTCP Token Ring Extension software, or the manufacturer must provide its own extension software that is compatible with the MacTCP driver.
- To use the AppleTalk encapsulation feature of MacTCP to connect to systems outside of the AppleTalk internet, the AppleTalk network must contain a Datagram Delivery Protocol-Internet Protocol (DDP-IP) gateway.
- To use MacTCP software, you need system software version 6.0.5 or later, or system software version 7.0 or later.
- To use the MacSNMP software, you need system software version 7.0 or later, 4 megabytes (MB) of RAM, and an SNMP console that supports TCP/IP.

△ **Important** The *TCP/IP Connection* disk is a high-density disk. You need a high-density floppy disk drive to read this disk. △

Network environment

The MacTCP driver runs over LocalTalk, Ethernet, and Token Ring–compatible cable systems, as shown in Figure 1-1. A Macintosh Plus computer or later model can run the MacTCP driver.

The MacTCP driver is co-resident with AppleTalk protocols so that there can be concurrent TCP/IP and AppleTalk operation. For example, you could download a file with FTP while a print job is being sent to an Apple LaserWriter printer over LocalTalk cable. AppleTalk and MacTCP software can run over the same medium, or one protocol can run over one medium while another protocol runs over a different medium.

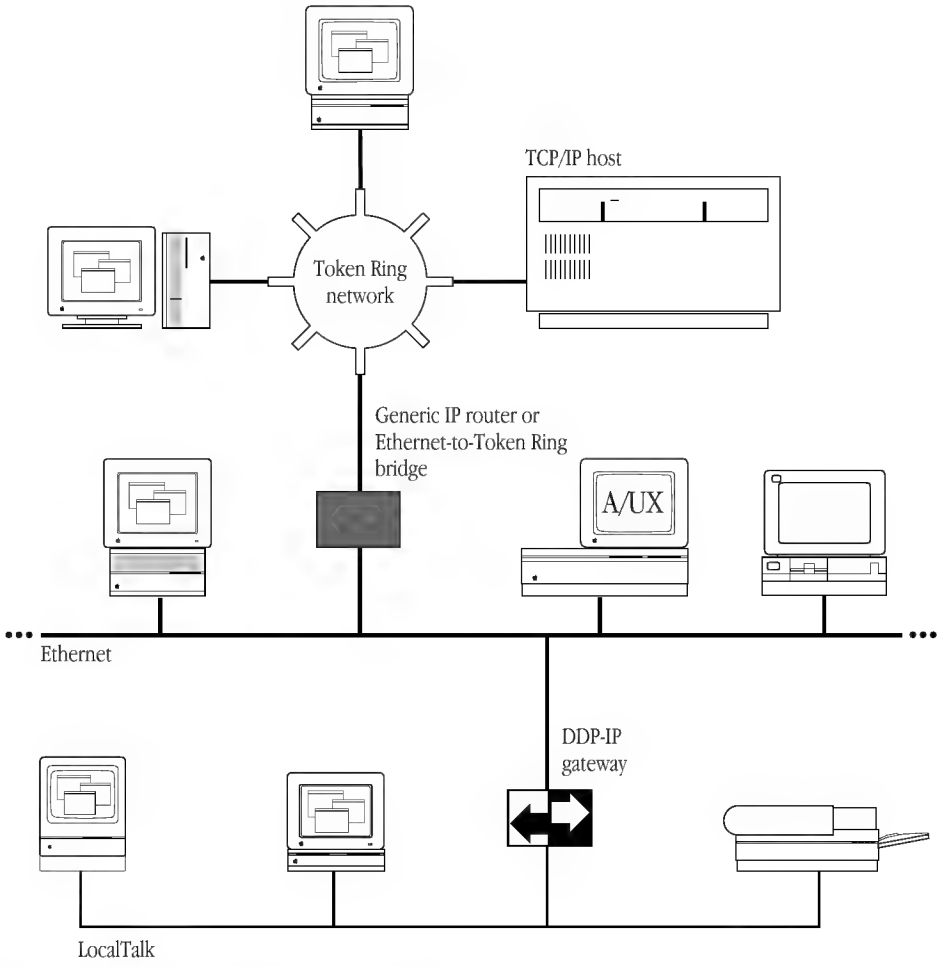


Figure 1-1 A MacTCP network configuration

DDP-IP gateway

To run MacTCP software on LocalTalk cable (or any other AppleTalk-compatible media), you need a Datagram Delivery Protocol-Internet Protocol (DDP-IP) gateway. This device takes a TCP/IP packet that is encapsulated in DDP, an AppleTalk protocol, and converts it to an Ethernet format. DDP-IP gateways can also assign addresses to MacTCP nodes and manage routing to other networks.

If the MacTCP software is running on LocalTalk, a DDP-IP gateway must be provided on the network as shown in Figure 1-1. By default, the DDP-IP gateway should be located in the same AppleTalk zone as the Macintosh computer running the MacTCP software. Alternatively, a single DDP-IP gateway can support Macintosh computers in multiple AppleTalk zones; in this case, the user must select the zone where the DDP-IP gateway resides, using the MacTCP control panel. It is further recommended that the user select server-based addressing when configuring the MacTCP driver.

2 About TCP/IP

The Transmission Control Protocol/Internet Protocol (TCP/IP) is a widely used industry standard for connecting multivendor computers. The TCP/IP protocol layers are fully compatible across all implementations on different hardware platforms, allowing different vendors' computers that run TCP/IP to interoperate and share data and services.

TCP/IP development began when the Defense Advanced Research Projects Agency (DARPA) decided there was a need for more reliable communication protocols on the ARPANET, its packet-switched wide area network. DARPA initiated a research project to define and implement a suite of protocols, and the researchers developed TCP/IP. Eventually TCP/IP became the standard protocol suite used on the DARPA Internet, a collection of networks that includes the ARPANET, Military Network (MILNET), National Science Foundation Network (NSFnet), and networks at universities, research institutions, commercial institutions, and military installations. Since then, hundreds of vendors have developed products that support TCP/IP, and many different networks use it.

TCP/IP supports an architecture of multiple networks interconnected by gateways. This interconnected set of networks is called an internetwork or internet. Figure 2-1 shows an example of an internet. For example, TCP/IP protocols can be used to connect networks on a college campus as well as geographically distant sites on a wide area network.

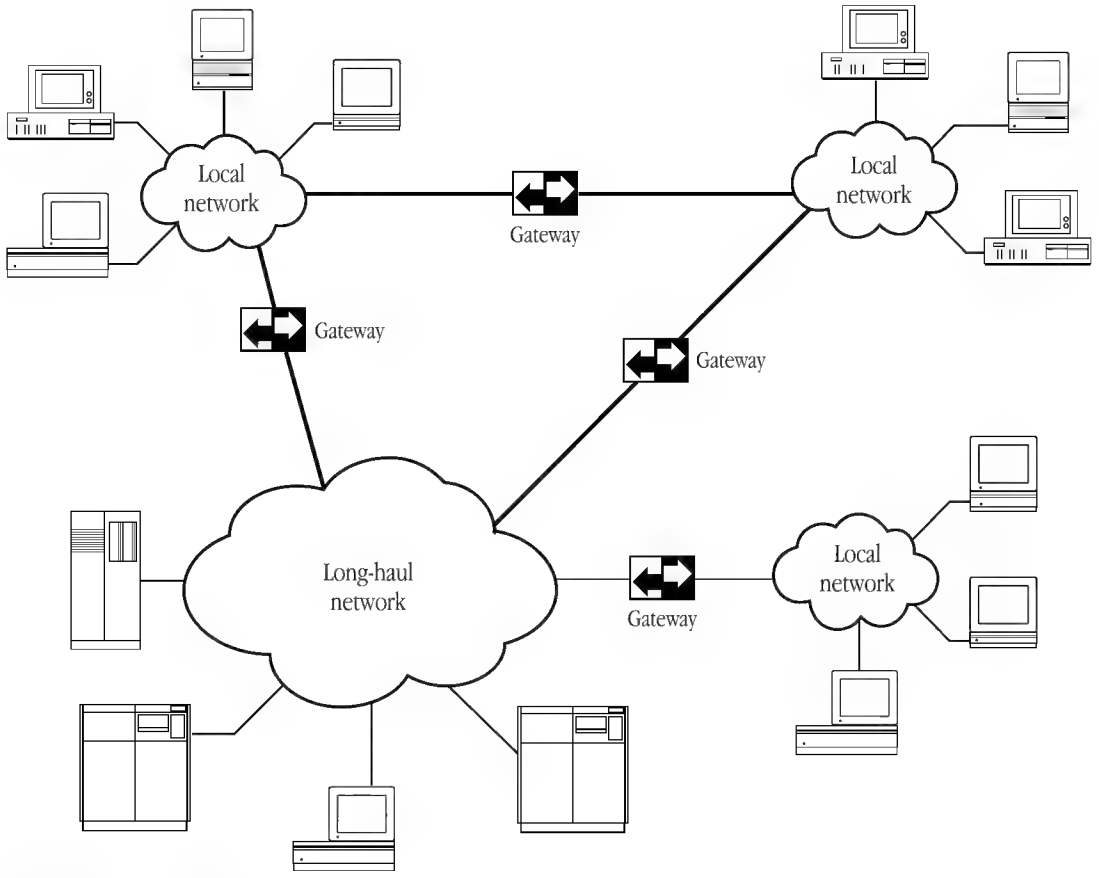


Figure 2-1 An internet

The family of protocols

TCP/IP is a family of protocols named after the fundamental protocols in the suite, the Transmission Control Protocol (TCP) and the Internet Protocol (IP). The protocols described in this guide are the ones most commonly supported by computers attached to TCP/IP networks.

TCP, IP, and the User Datagram Protocol (UDP) provide basic transmission facilities that are augmented by application services in higher-level protocols such as Telnet, the File Transfer Protocol (FTP), the Simple Mail Transfer Protocol (SMTP), and the Simple Network Management Protocol (SNMP).

SNMP and Apple's implementation of the protocol, MacSNMP, are discussed in detail in the *MacSNMP Administrator's Guide*.

Other protocols in the TCP/IP family are described in later chapters of this guide. The Address Resolution Protocol (ARP), the Reverse Address Resolution Protocol (RARP), and the Bootstrap Protocol (BootP) are described in Chapter 3. The Routing Information Protocol (RIP) and the Internet Control Message Protocol (ICMP) are described in Chapter 4.

Although TCP/IP was designed and tested before the International Standards Organization (ISO) defined the Open Systems Interconnection (OSI) Reference Model, it partially conforms to the OSI layers of networking functionality. Figure 2-2 shows a comparison of the OSI and the TCP/IP communications architecture. The TCP/IP protocols shown in Figure 2-2 are described in the following sections.

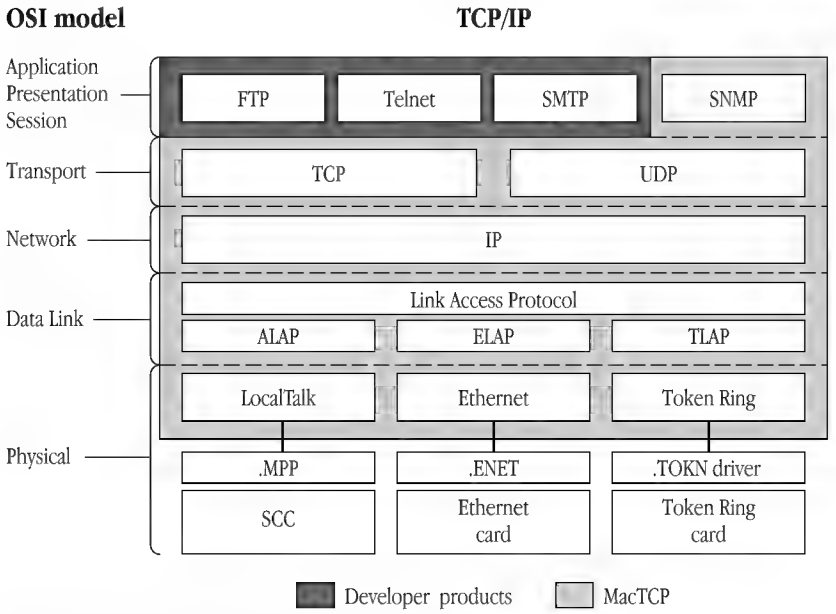


Figure 2-2 A comparison of OSI and TCP/IP

Internet Protocol (IP)

The Internet Protocol (IP) is responsible for sending data across multiple networks. IP accepts segments of data from TCP or UDP, places the data in packets called datagrams, and determines the correct path for the datagrams to take. The datagrams are sent across the internet, through as many gateways as needed, until they reach the destination host.

IP provides an addressing mechanism that allows routing between networks. The header of an IP datagram contains source and destination internet addresses so that any host in a network can route a packet to a destination, either directly or through a gateway.

IP has the ability to fragment a datagram as it is transmitted across a network. Since IP can be used with many different physical network implementations that specify different sizes for physical data frames, datagrams can be fragmented to fit into a smaller data frame. Fragments are reassembled as they arrive at the destination.

IP is often referred to as an unreliable delivery system because it makes a best-effort attempt to deliver all datagrams, but delivery is not guaranteed (TCP guarantees delivery). It is also called a connectionless delivery system because it routes each datagram separately. When IP receives a sequence of datagrams from TCP or UDP, it routes each datagram in the sequence individually, and each datagram may travel over a different path to the destination.

Transmission Control Protocol (TCP)

The Transmission Control Protocol (TCP) provides reliable transmission of data between processes. (Processes are application programs that communicate; for instance, a file transfer process on one host talks to a file transfer process on another host.) It ensures that data is delivered error-free, without loss or duplication, and in sequence.

Upper-layer protocols such as Telnet pass data to TCP for delivery to peer processes. TCP encapsulates the data into segments and passes the segments to IP, which puts the segments into datagrams and passes them across the internet. TCP at the receiving end checks for errors, acknowledges error-free segments, and reassembles the segments for delivery to upper-layer protocols. If a segment is lost or damaged, it will not be acknowledged, and the sending process will retransmit.

TCP has a flow-control mechanism so that computers of different speeds and sizes can communicate. When TCP at the receiving end sends an acknowledgment, it also advertises how much data it is prepared to accept on the next transmission.

User Datagram Protocol (UDP)

The User Datagram Protocol (UDP) provides unreliable transmission of data between processes. The UDP transport of data is unreliable because, unlike TCP, it does not provide error checking, it does not acknowledge that data has been successfully received, and it does not order incoming messages. UDP messages can be lost, duplicated, or arrive out of order. Like TCP, UDP messages are encapsulated in IP datagrams for delivery.

The advantage of UDP is that the overhead associated with establishing and maintaining an error-free TCP session is avoided. Upper-layer protocols that don't require reliability use UDP to transmit data. For instance, the domain name system uses UDP because reliability is not critical; if there is no response to a domain name query, the resolver simply retransmits. (The domain name system is described in Chapter 3.)

Telnet

Telnet is a remote access protocol that allows a terminal on one host to appear as if it were directly connected to a remote host on an internet. Telnet also makes a personal computer act like a terminal. It is usually implemented as user software that initiates sessions to a remote location and server software that listens for connections from remote users.

File Transfer Protocol (FTP)

The File Transfer Protocol (FTP) is used to transfer files across an internet. A host can connect to a remote host on an internet and send or receive files, list directories, and execute simple commands. Like Telnet, FTP is usually implemented as user and server software. The user software interacts with the user at a host, and the server software receives requests from remote users to store or retrieve files.

Simple Mail Transfer Protocol (SMTP)

The Simple Mail Transfer Protocol (SMTP) transfers electronic mail messages from one host to another, across an internet. SMTP specifies the commands necessary to send mail and is used with a standard that specifies the general structure of a mail message.

Simple Network Management Protocol (SNMP)

The Simple Network Management Protocol (SNMP) is a widely accepted standard for managing devices on a multivendor network. An SNMP network management system consists of SNMP management software running on a computer called a *console* and SNMP agent software that is installed on each networked computer. The agents installed on a networked computer collect information—called *variables*—from the computer and relay this information to the management console.

MacSNMP is Apple Computer's implementation of SNMP on the Macintosh. It provides the agent side of an SNMP network management system, allowing Macintosh computers on multivendor networks to be managed by third-party SNMP consoles.

3 TCP/IP Addressing Conventions

For computers on the internet to refer to each other, each machine must be assigned a universal address. This chapter describes the addressing scheme that was developed to allow each TCP/IP host on the internet to be identified uniquely.

Internet addresses

Each host on a TCP/IP internet is assigned a unique 32-bit internet address (also called the *IP address*). The address is divided into two fields, called the *network field* and the *host field*. The network field identifies a network on the internet to which the host attaches (so that all hosts on the same network share the same network field), and the host field identifies a particular host attached to that network.

The network field is assigned by a central authority, the Network Information Center (NIC). Local administrators assign the host field of the address. (Note that only networks that might attach to the DARPA Internet need to obtain the network address from the NIC.)

Three IP address classes—A, B, and C—provide for the following network configurations:

- Class A addresses are used for a few networks with many hosts—for instance, the ARPANET.
- Class B addresses are used for medium-sized networks—for instance, a university network.
- Class C addresses are used for a large number of small networks—for instance, an Ethernet local area network (LAN).

The first bits of the address identify the address class, and the number of bits assigned to the network and host field of the address differs for each class. For instance, Class A addresses have 1 class identifier bit, 7 network identifier bits, and 24 host identifier bits. This allows for 128 Class A networks, where each network can support up to 16 million hosts. Figure 3-1 shows the class identifier bits and the number of bits allocated to the network and host fields for each address class.

To make the addresses easier to work with, they are written in dotted decimal notation. Each octet of the 32-bit address is assigned its decimal equivalent, and decimal points separate the integers.

For example, the 32-bit address 10000100 00001101 00000010 00011110 is written in dotted decimal notation as 132.13.2.30.

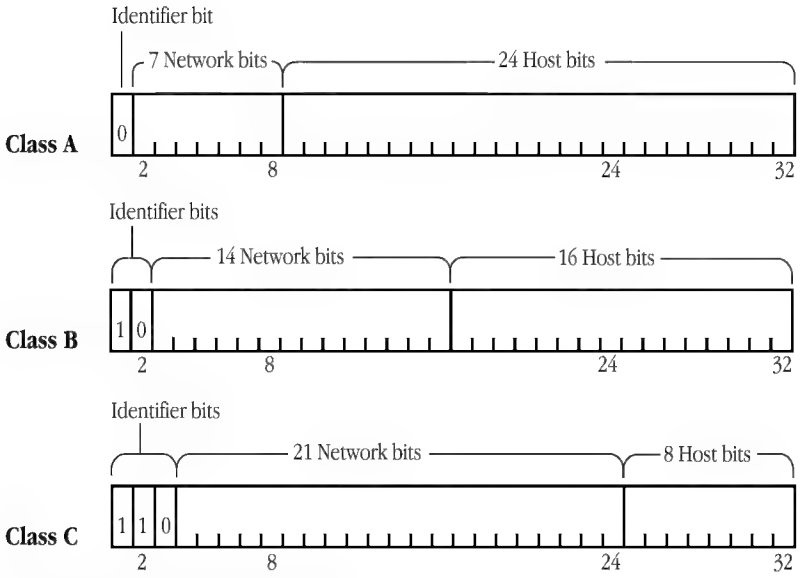


Figure 3-1 An IP address structure

Subnetwork addressing

The internet addressing scheme, designed for a few hundred networks, did not anticipate the proliferation of LAN technology. Organizations created large networks consisting of many LANs connected by gateways, and there was an explosive growth in the number of networks on the internet. Assigning every LAN on the internet its own network identifier created two problems:

- Immense administrative overhead is required to manage the addresses.
- Internet routing tables cannot accommodate many network addresses.

A technique called subnetwork addressing (or subnetting) was devised to deal with this problem. Subnetting allows multiple physical networks (called subnetworks) to share the same internet network number. For example, a university with two LANs can use subnet addressing so that both campus subnetworks share a single network number. The subnet structure is not visible to the rest of the internet; the route to the network is the same no matter what subnet the host is on.

The previous section stated that the internet address is divided into network and host fields. With subnetting, the address is conceptually divided into a network field and a local field, and the local field is divided into subnet and host fields. Various schemes (defined by subnet addressing standards) are used to divide the local field of the address into subnet numbers; the internet site determines which scheme is implemented.

Consider how Pundit University has subdivided its assigned Class B internet address, 190.10.0.0, for the two LANs on campus. They divided the local field of the address into an 8-bit subnet identifier and an 8-bit host identifier. LAN1 has the address 190.10.1.0 and LAN2 has the address 190.10.2.0. Figure 3-2 illustrates the addressing scheme at Pundit University.

In the figure, the rest of the internet perceives that it is sending data to one network. The gateway routes packets to the appropriate LAN by examining the third field in the address.

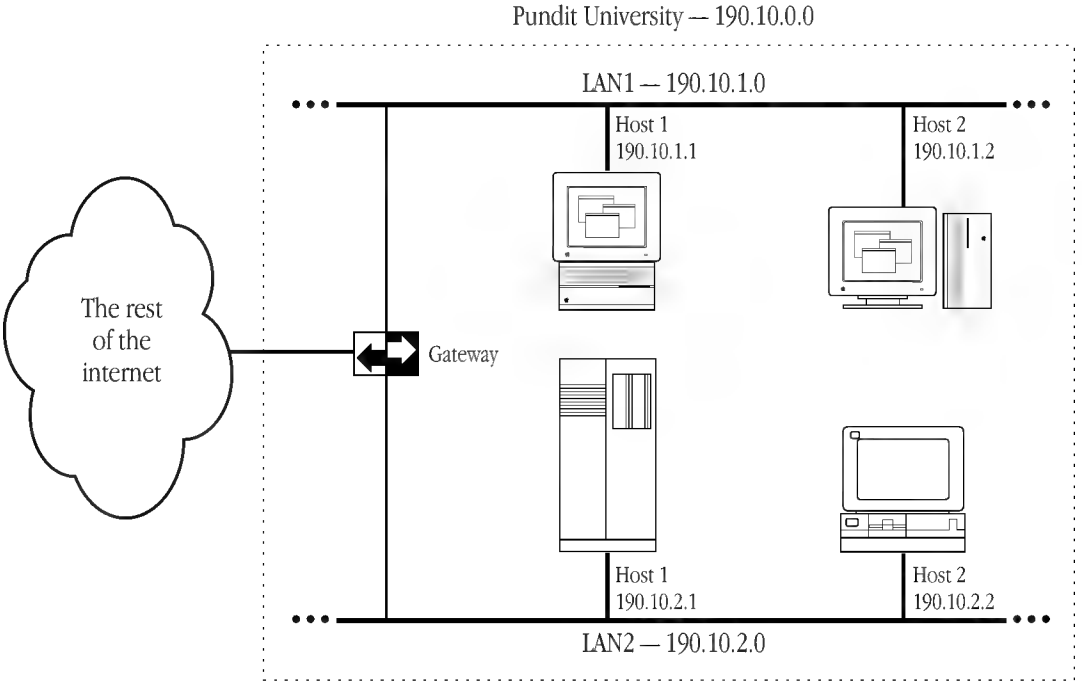


Figure 3-2 Subnetting at Pundit University

Subnetwork masks

An internet site that has implemented subnet addressing must choose a subnetwork mask (or subnet mask), which is used by network software to identify the host number field from the subnet number and network number fields. The portion of the address to be allocated to the subnet is defined (for example, Pundit University used the third field of the address to identify the subnet). Then bits are set in the 32-bit subnet mask to correspond to the IP address.

A subnet mask bit is set to 1 if the corresponding bit in the internet address is part of the network number and subnet number fields, and to 0 if the corresponding bit in the address is part of the host number field. The subnet mask for a Class A address might be 11111111 11111111 00000000 00000000 (or 255.255.0.0 decimal notation). Since this is a Class A address, octet 1 identifies the network field and octets 2, 3, and 4 identify the local field. The mask demarcates octets 3 and 4 as the host number field; therefore, the system knows that octet 2 of the address identifies the subnet number.

In theory, each LAN at the internet site could have a different number of bits allocated to its subnet field and therefore have different subnet masks. However, it is generally recommended that a given network have a single subnet mask that is the same for all of its component LANs.

The domain name system

Because users would rather refer to machines using meaningful, symbolic names rather than long strings of numbers, the domain name system was created to map internet addresses to names.

The hierarchical naming scheme accommodates a large set of names and allows local autonomy in assigning names. A domain name is divided into subnames (called *labels*), separated by periods, for instance

```
english.pundit.edu
```

In this example, `edu` is the top-level domain and each label further specifies a subdomain. The Network Information Center (NIC) administers the top-level domains and is responsible for assigning subdomains. Table 3-1 shows the top-level domains specified by the NIC.

Table 3-1 The top-level domains

Domain name	Meaning
COM	Commercial organization
EDU	Educational institution
GOV	Government institution
MIL	Military group
NET	Major network support centers
ORG	Organizations other than the above
ARPA	Temporary ARPANET domain
ISO country code	Countries other than the USA

After an organization obtains authority for a domain from the NIC, it can assign subordinate domain names. For instance, Pundit University obtained authority for the domain `pundit.edu`, and the English Department at Pundit University obtained authority for the domain `english.pundit.edu`.

The organization with authority over a domain must maintain a domain name server that maps domain names to internet addresses. If the English Department at Pundit University obtained a new computer, Hamlet, the name

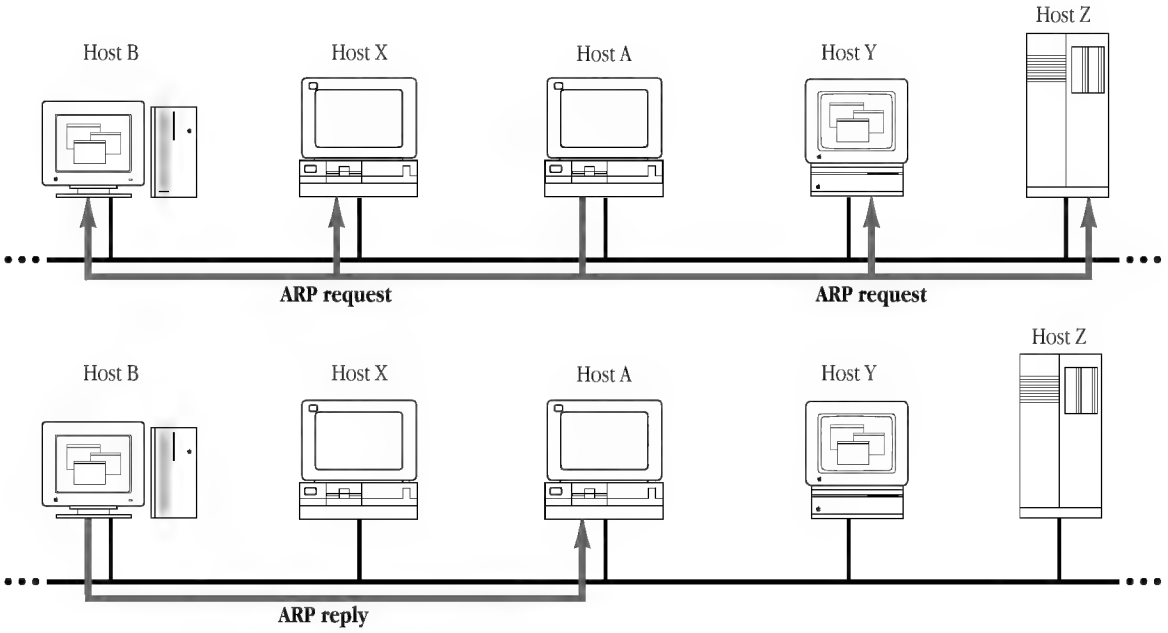
```
hamlet.english.pundit.edu
```

would be added to the database of a domain name server, along with the computer's internet address.

Hosts participating in the domain name system must have domain name resolvers that request domain name information from domain name servers. The name resolver contacts a local name server to obtain the internet address associated with the domain name. The local name server may need to contact other domain name servers to obtain the internet address.

Address Resolution Protocol (ARP)

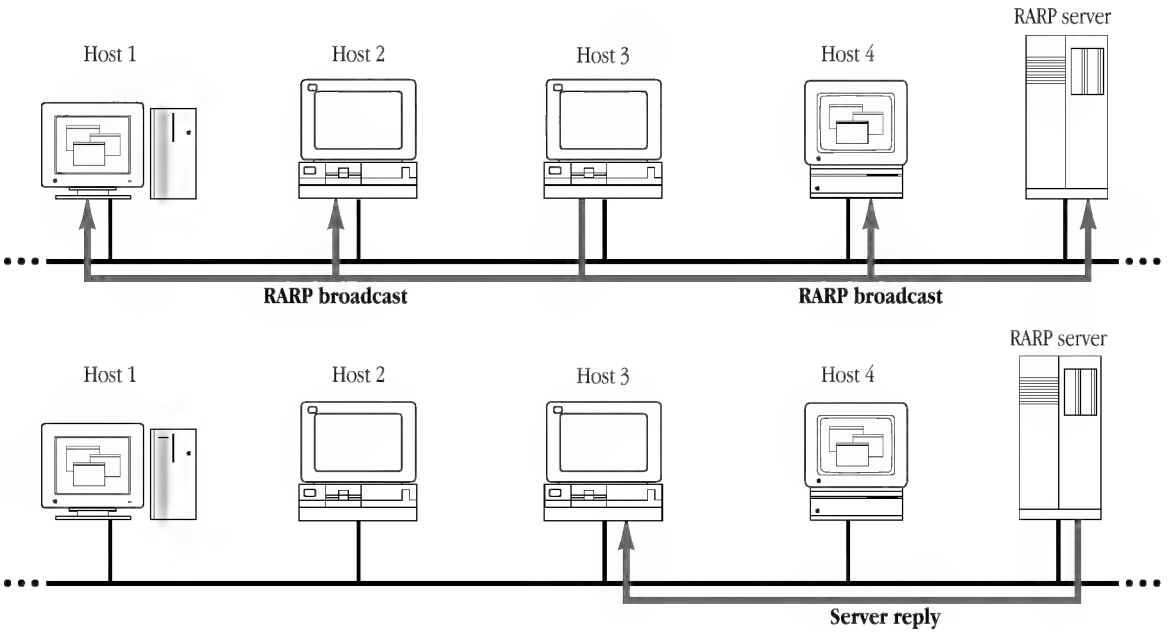
The Address Resolution Protocol (ARP) is a protocol in the TCP/IP protocol suite that maps internet addresses to physical network addresses. If Host A wants to communicate with Host B and it only knows the internet address of B, it can use ARP to obtain B's physical address. Host A broadcasts an ARP request that contains the internet address of Host B. All hosts on the network receive the request, but only Host B recognizes the internet address and replies with its physical address. Host A receives the reply, learns B's physical address, and delivers its packet directly to B. The following figure shows an ARP request and reply.



Reverse Address Resolution Protocol (RARP)

The Reverse Address Resolution Protocol (RARP) maps physical network addresses to internet addresses (the opposite function of ARP).

RARP provides a way for a host to obtain its internet address. The host broadcasts a RARP request that contains its physical network address. All hosts on the local network receive the request; however, only RARP servers can process the request and provide the internet address. (RARP will work only if there's a RARP server on the network.) The RARP server consults its database of internet addresses, then sends the information back to the host that made the request. The following figure shows a RARP broadcast and a RARP server reply.



Bootstrap Protocol (BootP)

The Bootstrap Protocol (BootP), like RARP, provides a way for a host to find its internet address. A host running BootP broadcasts a BootP request. A BootP server returns a response that contains the internet address of the host, the address of a bootserver, the address of an intervening gateway (if present), and other useful configuration information such as the subnet mask and addresses of domain name servers.

4 Routing

A packet transmitted by a host on the internet may only need to take a short jaunt across the local network, or it may have to cross many gateways and networks to reach its destination. The process of finding a path over which the packet can travel to reach its destination is called *routing*. This chapter describes how TCP/IP manages routing.

Gateways

If a host is transmitting to a destination on its own network, routing a packet involves finding the physical address of the destination host (using the Address Resolution Protocol) and sending the packet over the physical network to its destination. When the destination is on a different network, the packet is routed to the nearest gateway. A gateway is a machine that interconnects two networks and passes packets from one network to another. In Figure 4-1, three networks are interconnected by two gateways.

If the local gateway is not connected to the destination network, the packet is forwarded to other gateways until it reaches a gateway that is directly connected to the destination network.

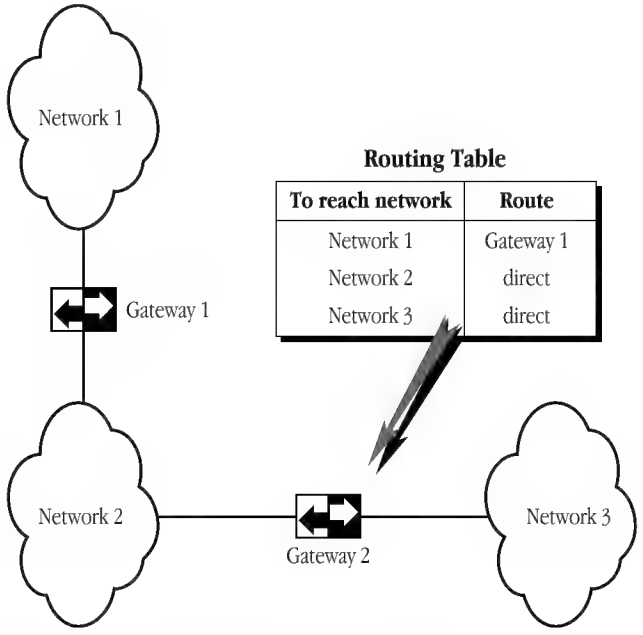


Figure 4-1 Gateways connecting networks

Routing tables

All gateways in the internet have routing tables that contain pairs of network addresses and gateway addresses. Each network address is linked with the gateway address of the gateway to be used to get to that network. Routing decisions are based on the network number of the destination address rather than the host number to keep routing tables small. Figure 4-1 shows an example of a gateway routing table.

Routing protocols

Routing protocols provide a way for gateways to find each other, keep up-to-date routing information, and report communication problems.

Routing Information Protocol (RIP)

Some gateways use the Routing Information Protocol (RIP) to exchange network routing information. Gateways broadcast their routing tables to neighboring gateways. If a RIP message contains new information, gateways update their routing tables.

RIP is intended for low-delay local area networks (LAN), although it is used in wide area networks. A widely used version of RIP is the routed software that is released with the 4.3BSD UNIX® system.

RIP can also be used to locate gateways on a LAN. Any computer broadcasting RIP packets is likely to be a gateway.

Internet Control Message Protocol (ICMP)

Gateways and hosts use the Internet Control Message Protocol (ICMP) to report communication problems. For instance, if a packet cannot be delivered because the destination host is disconnected from the network, an ICMP message may be returned to the sending host stating that the destination is unreachable. ICMP is primarily used by gateways to notify the source host of delivery or routing problems.

ICMP is an integral part of the Internet Protocol (IP). Successful IP routing requires ICMP services to report error conditions. ICMP messages are encapsulated in IP datagrams, transmitted to the destination gateway or host, and processed by IP software.

Part 2 Procedures

5 Configuring MacTCP

This chapter describes how to use MacTCP Admin to configure the MacTCP driver for your network users. Read the second section "Configuration Tools in MacTCP Admin" before you start configuration, because that section provides an overview of the MacTCP control panel and the Administrator dialog box. You use these tools to configure the MacTCP driver.

You can configure the MacTCP software in several ways, depending on how much of the configuration you want to leave to your network users. Read the section "Configuration Scenarios" to determine your strategy.

This chapter assumes that you are opening the MacTCP control panel screens for the first time. If you have configured the driver once, the values that appear will be somewhat different from those depicted here.

Make sure that you have installed the MacTCP software according to the instructions in *TCP/IP Administration: Overview and Installation* before you proceed with the tasks described in this chapter.

The MacTCP Admin and MacTCP files

Recall from the *TCP/IP Administration: Overview and Installation* manual that, as network administrator, you have installed a file named MacTCP Admin. The MacTCP and MacTCP Admin files both contain the configuration tools that modify resources in the MacTCP file and the MacTCP Prep file. However, the MacTCP Admin file includes an extra option, *Protected,* that leaves the resulting MacTCP file only partially configurable by the user.

Since the network administrator should control the option to protect or unprotect the configuration, you should not distribute the MacTCP Admin file to the user. Only the network administrator should use this file to configure the driver. The user can perform either full or partial configuration by running the MacTCP file.

In its default state, the MacTCP file is unprotected. If you plan to give the user full configuration authority, simply distribute the unprotected MacTCP file to the user. Otherwise, use MacTCP Admin to partially or completely configure the driver and protect the configuration, then distribute the MacTCP file to network users.

Configuration tools in MacTCP Admin

MacTCP Admin contains two MacTCP configuration tools: the MacTCP control panel and the Administrator dialog box. The way you use these tools depends on the configuration scenario you choose to implement. (These scenarios are described in the section "Configuration Scenarios" later in this chapter.)

The MacTCP control panel

The top-level configuration tool is the MacTCP control panel. It is used to set link level information and, optionally, to set the IP address in decimal notation. If you set the IP address in the MacTCP control panel, portions of the Administrator dialog box are automatically filled out.

The appearance of the MacTCP control panel in system software version 6.0.*x* environment differs from the control panel in version 7.*x*. However, the function of the MacTCP control panel is the same in either environment.

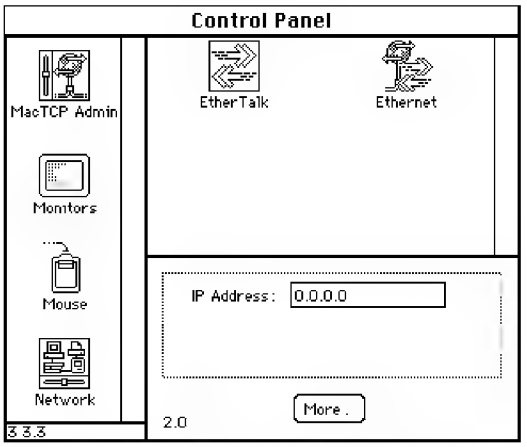


Figure 5-1 A view of the MacTCP control panel in version 6.0.*x*

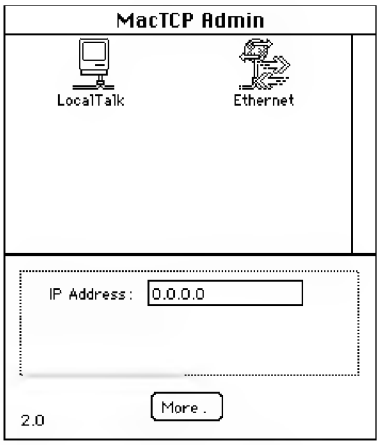


Figure 5-2 A view of the MacTCP Admin panel, the MacTCP control panel in version 7.*x*

The Administrator dialog box

The lower-level configuration tool is the Administrator dialog box, which is accessed through the More button on the MacTCP control panel.

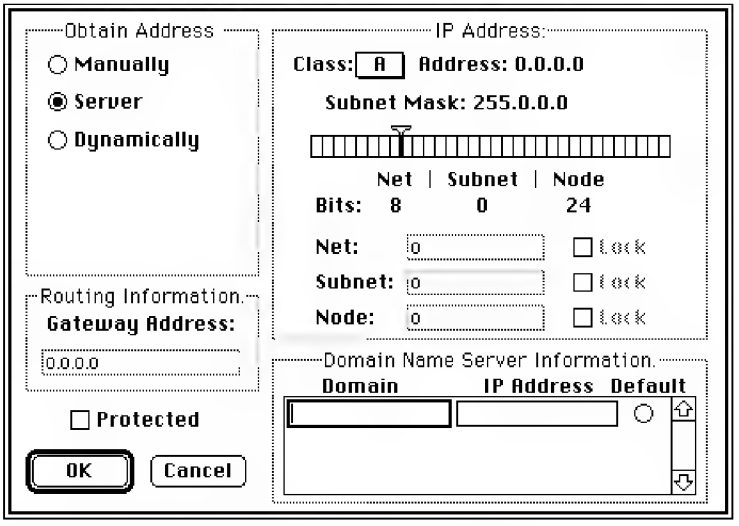


Figure 5-3 A view of the Administrator dialog box

You use the Administrator dialog box to enter detailed configuration information. The Administrator dialog box in the MacTCP Admin file also allows you to select the Protected checkbox, to protect the configuration from further modification. This option is not available through the Administrator dialog box in the MacTCP file; the checkbox either is dimmed (to indicate that the configuration has been protected) or does not appear.

The Administrator dialog box can be used by the network administrator and by users assigned full configuration authority. Users with partial configuration authority can view the dialog box but cannot modify it.

The following paragraphs give an overview of the Administrator dialog box features.

Obtain Address box

This is where you select the method with which you set the IP address. You have three options:

- If you select the Manually button, you must fill in some or all of the fields in the IP Address box.
- If you select the Server button, the IP address for the Macintosh computer is automatically obtained from a server every time the user starts up the computer. This option requires a RARP or BootP server on an Ethernet, or a MacIP-compatible Datagram Delivery Protocol-Internet Protocol (DDP-IP) gateway on an AppleTalk network.
- If you select the Dynamically button, the node portion of the IP address for the Macintosh computer is set dynamically every time the user starts up the computer. If you use this option, you must also set some of the fields in the IP Address box.

IP Address box

This is where you set the IP address class, subnet mask, net, subnet, and node numbers. You can fill in some or all of these fields depending on the configuration scenario that you choose to implement.

Routing Information box

This is where you set the gateway address in dotted decimal notation if the Routing Information Protocol (RIP) is not implemented on your network.

Domain Name Server Information box

This is where you set the IP addresses of domain name servers and the domains over which they have authority.

Protected checkbox

If you click this checkbox, the user is not able to modify any of the fields in the Administrator dialog box. The screen is displayed with all the fields dimmed.

Configuration scenarios

You can configure the MacTCP driver in several ways; you must decide how much of the configuration you want to leave to network users. The following scenarios describe the possible strategies and summarize the configuration process for each. Figure 5-4 shows the chapter sections to which you must refer to accomplish each scenario.

Scenario A

Configure the MacTCP driver so that the user does not have to fill in any IP address information in the MacTCP control panel. If this is your strategy, you have two options. You can set the IP address in the MacTCP control panel (in decimal notation) and then set the subnet information in the Administrator dialog box (if appropriate). Or you can select the Manually button in the Administrator dialog box and then set the IP address class, subnet mask, net, subnet, and node numbers. If you select the latter method, you must configure MacTCP software for each network user.

Scenario B

Configure the MacTCP driver so that the user must fill in the IP address in the MacTCP control panel (in decimal notation). If this is your strategy, select the Manually button in the Administrator dialog box and then set the IP address class and subnet mask. Do not fill in the Net, Subnet, and Node boxes. If you select this method, you can distribute the configured MacTCP software to several users.

Scenario C Configure the MacTCP driver so that the user must fill in the node portion of the IP address in the MacTCP control panel. If this is your strategy, select the Manually button in the Administrator dialog box and then set the IP address class, subnet mask, net number, and subnet number. Do not type the node number in the Node box. If you select this method, you can distribute the configured MacTCP software to several users.

Scenario D Configure the MacTCP driver so that the address is automatically assigned. (The user does not have to fill in any IP address information in the MacTCP control panel.) If this is your strategy, select the Server button in the Administrator dialog box. If you select this method, you can distribute the configured MacTCP software to several users.

Scenario E Configure the MacTCP driver so that the node portion of the address is assigned dynamically. (The user does not have to fill in any IP address information in the MacTCP control panel.) If this is your strategy, select the Dynamically button in the Administrator dialog box and then set the IP address class, subnet mask, net, and subnet numbers. If you select this method, you can distribute the configured MacTCP software to several users.

Scenario F The user is granted full configuration authority and can use the Administrator dialog box to configure the MacTCP software. If you select this scenario, you may distribute the unconfigured MacTCP file. The user should refer to the *TCP/IP Connection User's Guide,* Chapter 3, "Configuring MacTCP."

The remainder of this chapter describes the steps you must take to accomplish the configuration scenario you have selected.

For this scenario . . .

A	B	C	D	E	F	*. . . refer to these sections*
■	■	■	■	■		Opening the MacTCP control panel
■						Setting the IP address in decimal notation
■	■	■	■	■		Opening the Administrator dialog box
■	■	■	■	■		Setting the IP address
■	■	■		■		Setting the address manually
■	■	■		■		Setting the IP address class
■	■	■		■		Setting the subnet mask
■		■		■		Setting the IP address (integer format)
■		■		■		Setting the net number
■		■		■		Setting the subnet number
■						Setting the node number
			■			Obtaining an address from a server
				■		Setting the node number dynamically
■	■	■	■	■		Setting the gateway address
■	■	■	■	■		Setting domain name server information
■	■	■	■	■		Protecting the configuration
					■	Giving the user full configuration power

Figure 5-4 A road map to configuration scenarios

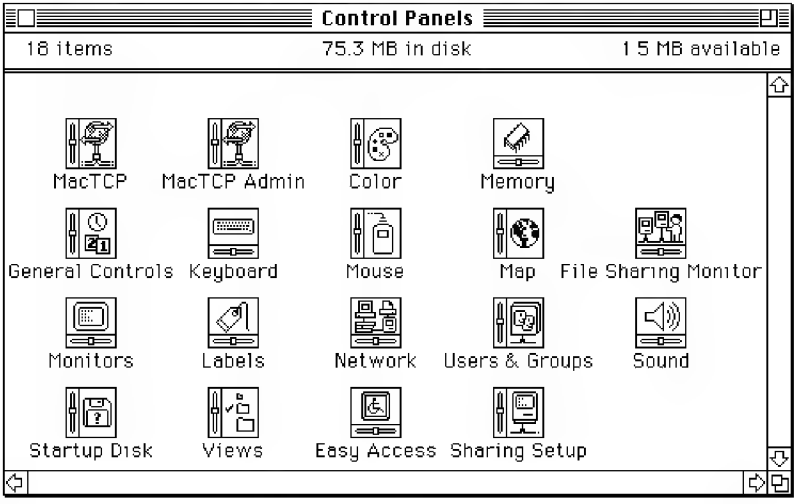
The shaded squares under each scenario indicate the sections of this chapter you should read to accomplish that scenario.

Opening the MacTCP control panel

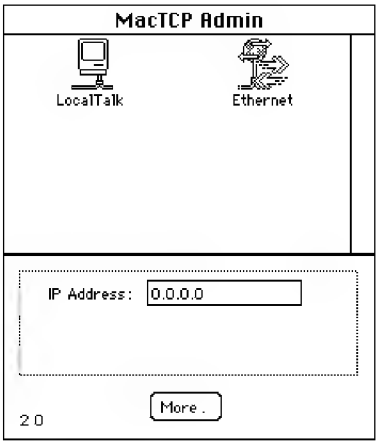
This section describes how you open the MacTCP control panel in system software versions 7.*x* and 6.0.*x*. Read the section that applies to your environment.

Version 7.*x* environment

Choose Control Panels from the Apple menu, and the Control Panels window appears with a scrollable list of icons as shown here:



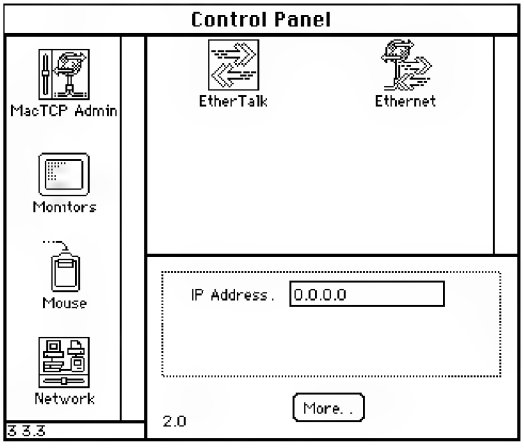
Double-click the MacTCP Admin icon (it may be necessary to use the scroll bar to bring the icon into view). The MacTCP Admin control panel appears, as shown in the following figure. This panel serves as the MacTCP control panel.



Version 6.0.*x* environment

Choose Control Panel from the Apple menu, and the panel appears with a scrollable list of icons at the left side of the window.

Click the MacTCP Admin icon (it may be necessary to use the scroll bar to bring the icon into view). The MacTCP control panel appears to the right of the window as shown in the following figure.



Setting link level information

The top half of the MacTCP control panel displays the available link level protocols on which the MacTCP driver can run. Different icons are displayed depending on your network configuration.

If your Macintosh computer is using an Ethernet interface card, make sure that the software for the card is installed. The MacTCP control panel also provides a way for you to learn the hardware address of your Ethernet interface card if you should need this information for purposes of troubleshooting. Press and hold down the option key and click the Ethernet icon. The hardware address of the card is displayed beneath the icon, as shown here:

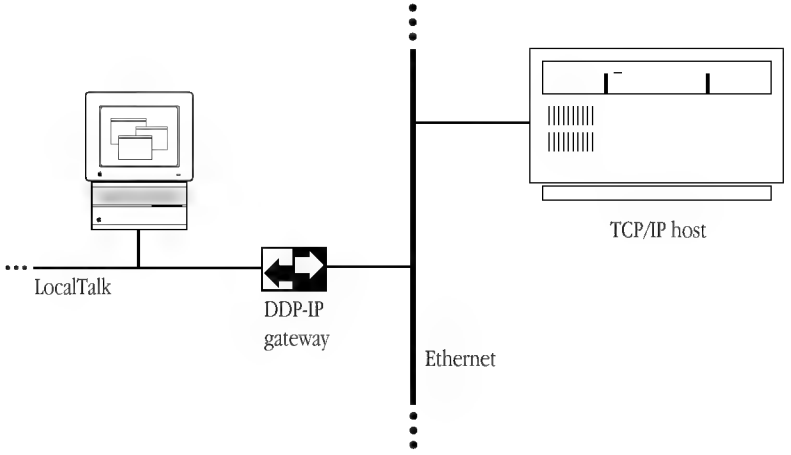
02608C01CF13

Five possible network configurations are described on the following pages. Select the one that applies to your network and follow the instructions to set the link level information.

◆ **Note** This section is provided to help you set the link level information for your own computer. You cannot remotely perform this configuration task for users because it involves specific information that is reported to the MacTCP control panel by the computer. The *TCP/IP Connection User's Guide* includes these instructions. (The User Instructions file includes a less detailed description.) A note advises users to contact you if they have questions about their network configuration or the zone where the DDP-IP gateway is located. ◆

Network configuration 1

The following figure illustrates one possible network configuration: a Macintosh computer on an AppleTalk network using LocalTalk cable with a gateway to an internet.

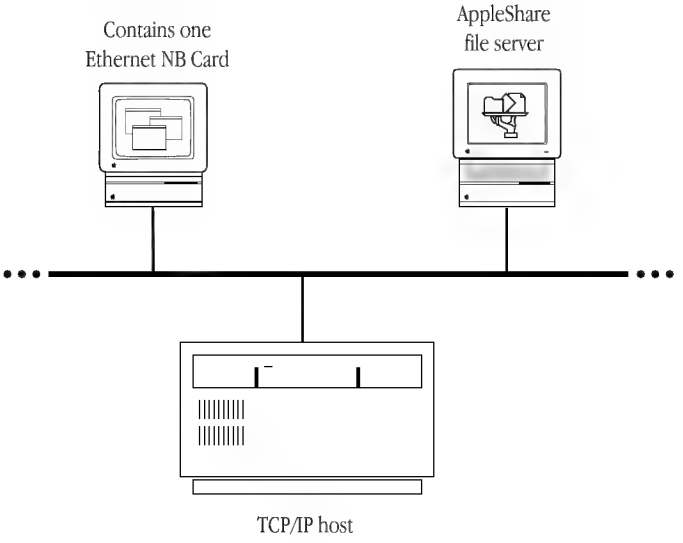


If this is your network configuration, the upper section of the MacTCP control panel contains the following icon.

The box beneath the icon displays the network zone where your DDP-IP gateway is located. If your gateway is located in another zone, direct the pointer to the zone box beneath the icon and press the mouse button. A pop-up menu appears with a list of zone names as shown in the following figure. Holding the mouse button down, drag the pointer to the list and highlight the appropriate zone. When you release the mouse button, the pop-up menu disappears, and the zone name you selected appears in the box.

Network configuration 2

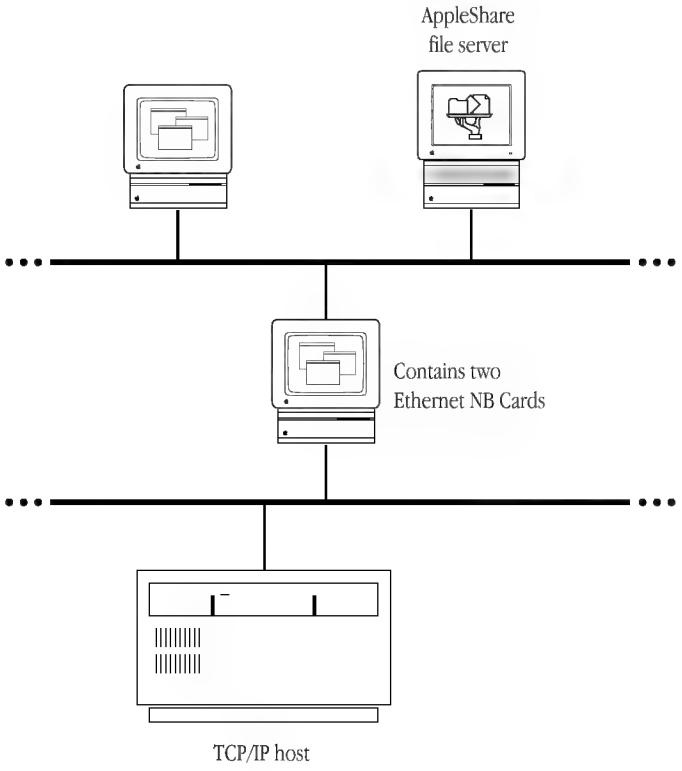
The next figure illustrates a second possible network configuration: a Macintosh computer with one Ethernet NB Card on an AppleTalk network using Ethernet cable.



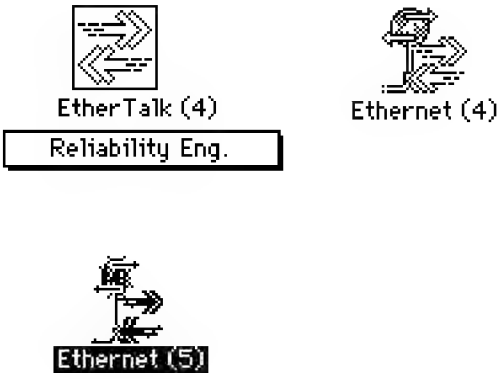
If this is your network configuration, the upper section of the MacTCP control panel contains the following icons. Select the Ethernet icon to allow your Macintosh computer to use TCP/IP to communicate with other TCP/IP hosts on the network. (AppleTalk is already being used to communicate with the AppleShare file server and the LaserWriter printer.)

Network configuration 3

The next figure illustrates a third possible network configuration: a Macintosh computer with two Ethernet NB Cards (located in slots 4 and 5) on an AppleTalk network using Ethernet cable.

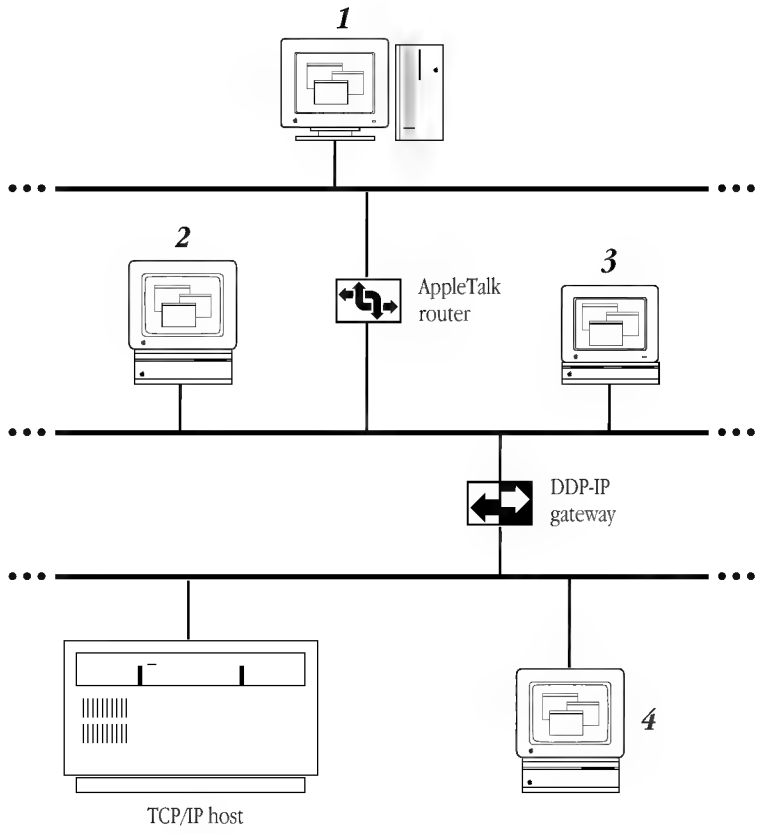


If this is your network configuration, the upper section of the MacTCP control panel contains the following icons. (If the Ethernet NB Cards are located in slots other than 4 and 5, the numbers in the icon names will be different.) Select the Ethernet (5) icon to allow your Macintosh computer to use TCP/IP to communicate with other TCP/IP hosts on that network.



Network configuration 4

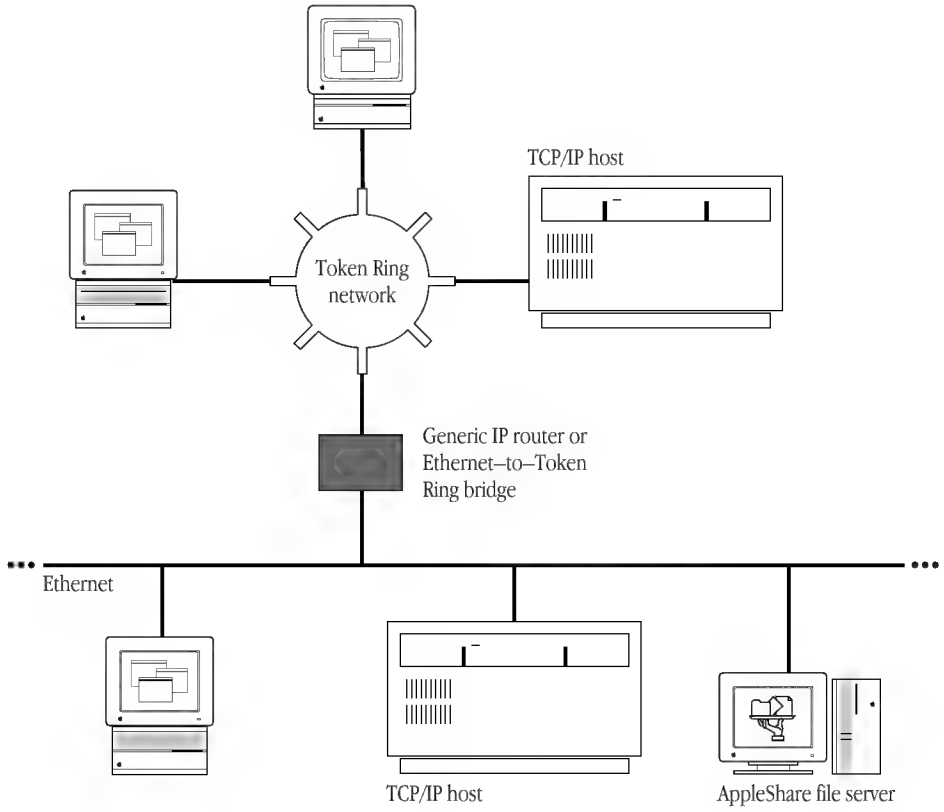
The next figure illustrates a fourth possible network configuration. Macintosh computers 1, 2, and 3 are on EtherTalk cable segments separate from the TCP/IP host. These computers use AppleTalk protocols to communicate with the gateway, and the gateway uses TCP/IP protocols to communicate with the TCP/IP host. Macintosh computer 4, on the same Ethernet as the TCP/IP host, uses standard TCP/IP protocols to communicate directly with the TCP/IP host.



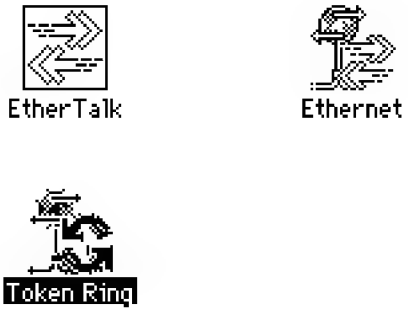
If this is your network configuration, the upper section of the MacTCP control panel contains the following icons. If you must go through a gateway to reach a TCP/IP host (as do computers 1, 2, and 3 in the previous illustration), make sure that the EtherTalk icon is selected. If you are on the same Ethernet as the TCP/IP host (as is computer 4), select the Ethernet icon.

Network configuration 5

The following figure illustrates a fifth network configuration: A Macintosh computer on a Token Ring network, connected either to an IP host on the Token Ring network or to an IP host on an Ethernet network through an IP router or Ethernet–to–Token Ring bridge.



If this is your network configuration, the upper section of the MacTCP control panel contains the following icons. Select the Token Ring icon to allow your Macintosh computer to use TCP/IP to communicate with other TCP/IP hosts on that network.



◆ **Note** If you have a Token Ring card installed in your computer, the Token Ring icon that appears in the MacTCP control panel includes the NuBus slot number. This number differs from the physical card slot number that is displayed in the Token Ring control panel. Figure 5-5 shows the Token Ring and MacTCP control panels for a Macintosh II computer with multiple Token Ring cards. Figure 5-6 maps the correspondence between the physical slot numbers shown in the Token Ring control panel and the NuBus slot numbers shown in the MacTCP control panel. ◆

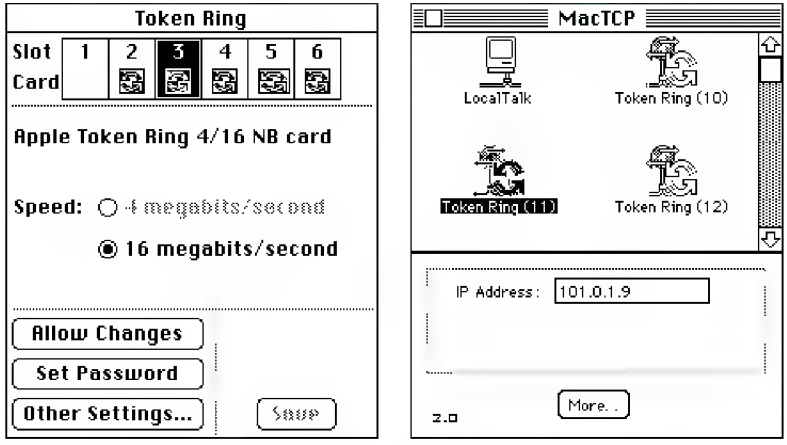


Figure 5-5 Multiple Token Ring cards in a Macintosh II computer, as seen in the Token Ring and MacTCP control panels

Computer model	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6
Macintosh II	9	10	11	12	13	14
Macintosh IIx	9	10	11	12	13	14
Macintosh IIfx	9	10	11	12	13	14
Macintosh IIcx	9	10	11			
Macintosh IIci	12	13	14			
Macintosh Quadra 700	13	14				
Macintosh Quadra 900	10	11	12	13	14	

Figure 5-6 Physical slot numbers (shaded) and NuBus slot numbers in various Macintosh computers

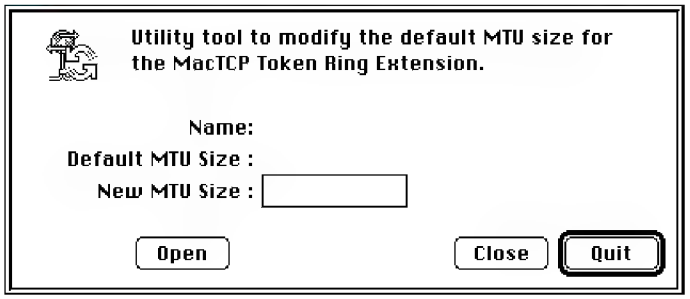
Adjusting the MTU size

The current version of the MacTCP Token Ring Extension software supports a Maximum Transmission Units (MTU) size of 2002 bytes for Token Ring network speeds of both 4 megabits per second (Mbits/second) as well as 16 Mbits/second. However, the MTU size can actually be much bigger than 2002 bytes for 16 Mbits/second speed networks. Administrators who want to take advantage of their faster networks can modify the default MTU size of the MacTCP Token Ring Extension software by using the MacTCP Token Ring MTU Tool included on the *TCP/IP Administration* disk. If you want to adjust the MTU size, copy the MacTCP Token Ring MTU Tool file from the *TCP/IP Administration* disk onto your hard disk.

If you distribute the MacTCP Token Ring MTU Tool to users, be sure to instruct them about its use. The user should consult the network administrator before changing the MTU size. Other hosts or routers connected to the ring may not support the new MTU size, causing interoperability problems in the network environment.

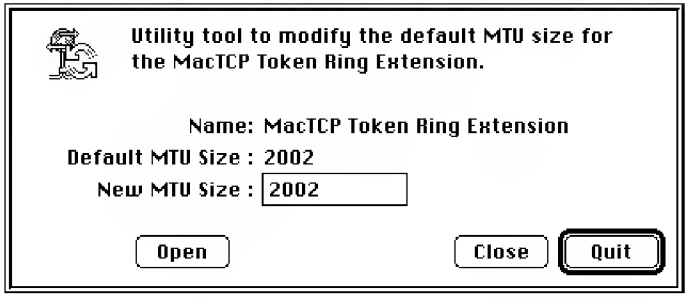
To adjust the MTU size of your computer, perform the following steps:

1 Open the MacTCP Token Ring MTU Tool by double-clicking the icon for the tool.



2 Click the Open button and open the MacTCP Token Ring Extension file using the standard file dialog box.

The MacTCP Token Ring MTU Tool displays the current setting as the default MTU size.

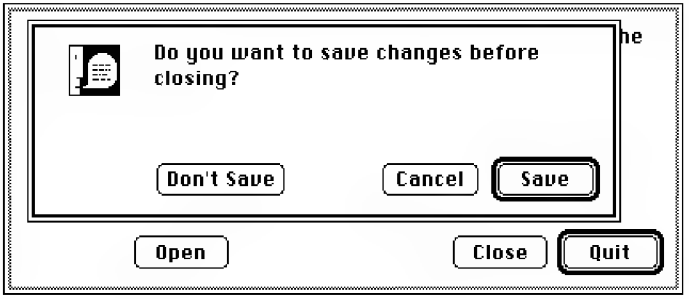

Utility tool to modify the default MTU size for the MacTCP Token Ring Extension.
Name: MacTCP Token Ring Extension
Default MTU Size : 2002
New MTU Size : 2002
Open
Close
Quit

3 Change the default MTU size.

The default MTU size is 2002 bytes. Change it by typing the new size in the New MTU size box.

4 Click the Close button.

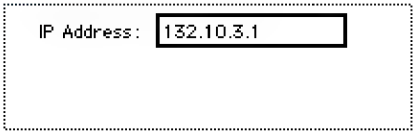
A dialog box appears, asking if you want to save the changes. Click the Save button. Then click the Quit button.



5 Restart the computer to use the new MTU size.

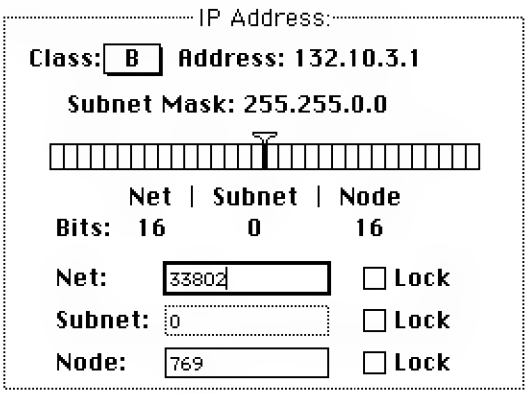
Setting the IP address in decimal notation

If you have decided to set the entire IP address for the user and you prefer to set the address in dotted decimal notation (for example, 132.10.3.1), type the address in the IP Address box as shown here:



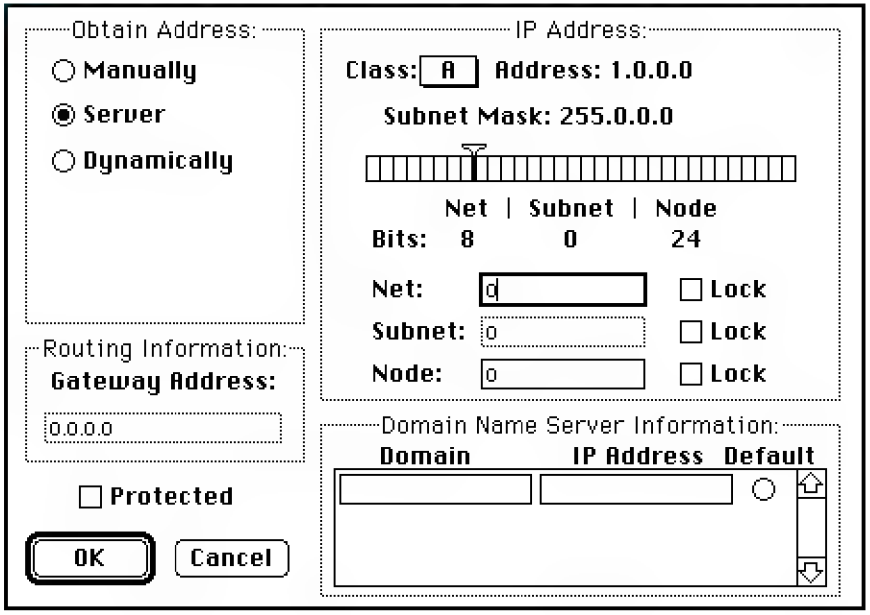
When you click the More button and the Administrator dialog box is displayed, the class, address, and net and node numbers are set, as shown in the following figure.

◆ **Note** Setting the address in the MacTCP control panel does not set the subnet mask. ◆



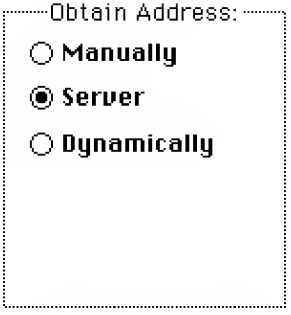
Opening the Administrator dialog box

Click the More button on the control panel to get to the Administrator dialog box, illustrated here. This panel is your main tool for configuring the MacTCP driver.



Setting the IP address

The Administrator dialog box provides you with three ways to set the IP address (if you did not set the decimal address in the MacTCP control panel). The Obtain Address box in the upper-left corner of the panel (shown here) allows you to select your preferred method for setting the address. Your selection determines whether the user must type the address information on the MacTCP control panel.



- If you select Manually, you must set the address manually using the fields in the IP Address box. See the next section "Setting the Address Manually."
- If you select Server, the address is obtained automatically from a server. This option requires a RARP or BootP server on an Ethernet, or a MacIP-compatible Datagram Delivery Protocol-Internet Protocol (DDP-IP) gateway on an AppleTalk network. See the section "Obtaining an Address From a Server" later in this chapter.
- If you select Dynamically, you must set the net and subnet portions of the address using the fields in the IP Address box, but the node portion of the address will be allocated dynamically (within the range of node numbers specified). See the section "Setting the Node Number Dynamically" later in this chapter.

◆ **Note** If you do not set the IP address in either the MacTCP control panel or the Administrator dialog box, then the user must type it in decimal notation on the MacTCP control panel. ◆

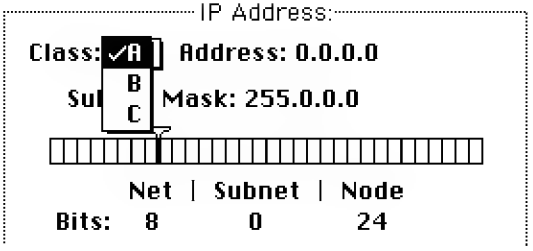
Setting the address manually

If you select the Manually option, you must set the address manually using the fields in the IP Address box. You can set either the entire IP address, or the net and subnet portions. Setting the entire address causes the IP address to appear on the MacTCP control panel. The user does not need to type any address information. Setting the net and subnet portions causes *Net, Subnet,* and *Node* boxes to appear on the MacTCP control panel. The user must type the node number.

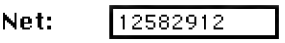
To set the address manually, click the Manually button located in the Obtain Address box. Then follow the steps described in the following sections.

Setting the IP address class

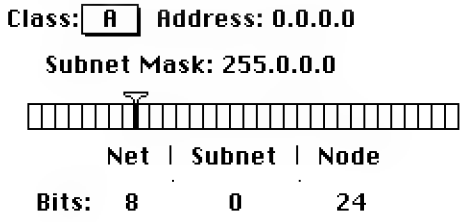
Move to the IP Address box and position the pointer on the Class box. Class A, the default setting, is currently in the box. Press the mouse button, and a menu of classes appears as shown here. The ✓ indicates which class is the current setting. If you want to change the class, drag the pointer to B or C.

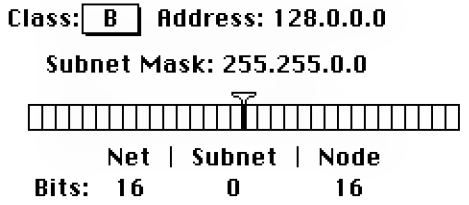


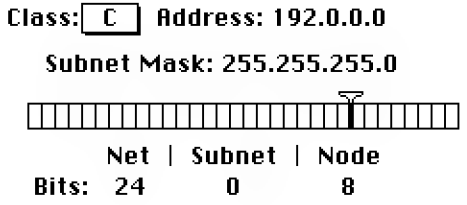
If you change the class, the new value that appears in the Net box is the minimum value allowable for the selected IP address class. For instance, if you select class C, the value in the net box changes to 12582912, which is the minimum value that can be used for class C addresses.



Note that changing the class causes the slider on the ruler to move. The address, subnet mask, and bits allocated to net, subnet, and node also change. The following figure shows the address, subnet mask, position of the slider, and the bit allocation for each class.







Setting the subnet mask

Perform this step only if you have implemented subnet addressing on your network. Use the slider on the ruler to set the subnet mask. Each box in the ruler represents one bit of the 32-bit IP address. A dark vertical line on the ruler indicates the number of bits allocated to the net portion of the address (as determined by the class selected). The slider can be moved anywhere along the ruler to the right of this darkened line. Place the pointer on the slider, hold down the mouse button, and drag the slider to the appropriate location on the ruler. When you move the slider, the subnet mask, the subnet bits, and the node bits change.

If you do not move the slider, the Subnet box remains dimmed.

△ **Important** If you want the user to set the IP address in the IP Address box of the MacTCP control panel (scenario B in the earlier section "Configuration Scenarios"), skip the next section. Continue with the configuration, referring to the section "Setting the Gateway Address" later in this chapter. The user will have to set the IP address in the MacTCP control panel as described in the user's guide. △

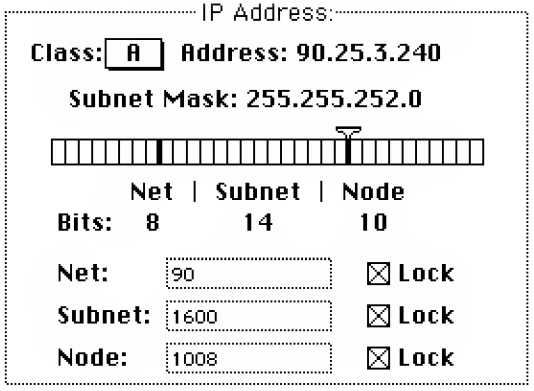
Setting the IP address (integer format)

In integer format, the IP address is broken down into bits (four sets with eight bits per set). The bits are allocated to net, subnet, and node according to the IP address class and subnet mask, then displayed as a decimal number. For instance, the address 90.25.3.240 broken down into bits, looks like this: 01011010.00011001.00000011.11110000

If the IP address class is A (8 bits compose the net portion of the address) and the subnet mask is 255.255.252.0 (or 14 bits of subnet and 10 bits of node), then the integer form of the address is as follows:

- *Net:* 90
- *Subnet:* 1600
- *Node:* 1008

If you want to set the IP address in integer format, type this information in the Net, Subnet, and Node boxes shown here:



△ **Important** If you are configuring the MacTCP driver so that the user has to type the node number in the MacTCP control panel (scenario C in the earlier section "Configuration Scenarios"), you must set the net and subnet portion of the address in integer format in the Net and Subnet boxes. △

Setting the net number The Net box contains the lowest net number that can be used, determined by the IP address class that was selected. Click twice in the Net box and type the net portion of the IP address in integer format. If you type a number over the maximum allowed for the selected IP address class, the last digit in that number is rejected; you must retype a valid number. If you type a number under the minimum allowed for the selected IP address class, a valid number is automatically assigned when you save your changes; therefore, be sure to choose a number over the minimum allowed for the selected IP address class.

If you click the Lock box to the right of the Net box, the net number is protected. The Net box is dimmed, and you cannot change its value unless you click the Lock box to deselect it. If you lock the value in the Net box, the user will not be able to change this number on the MacTCP control panel.

Setting the subnet number Note that you can set the subnet number only if you set the subnet mask. Click the Subnet box and type the subnet portion of the IP address in integer format. If you click the Lock box to the right of the Subnet box, the subnet number is protected. The Subnet box is dimmed, and you cannot change the value in the box unless you click the Lock box to deselect it. If you lock the value in the Subnet box, the user will not be able to change this number on the MacTCP control panel.

Setting the node number You now have three choices: set the node number, leave the Node box at the default and have the user set the node number, or have the node number assigned dynamically.

If you decide to set the node number, click the Node box and type the node portion of the IP address in integer format. If you click the Lock box to the right of the Node box, the node number is protected. The Node box is dimmed, and you cannot change the value in the box unless you click the Lock box to deselect it. If you lock the value in the Node box, the user will not be able to change this number on the MacTCP control panel.

If you decide to have the user set the node number in the MacTCP control panel, leave the default number in the box, and do not select the Lock box. Then continue with the configuration, starting with the section "Setting the Gateway Address" later in this chapter.

If you want the node number to be assigned dynamically every time the user starts up, see the section "Setting the Node Number Dynamically" later in this chapter.

Obtaining an address from a server

If you select the Server button in the Obtain Address box, the network address is obtained automatically from a network server. On an Ethernet network, the protocols BootP or RARP are used to set an address. On an AppleTalk network, a DDP-IP gateway sets the address.

To have a server provide the address, click the Server button in the Obtain Address box. (When you bring up the Administrator dialog box for the first time, Server is the default setting.) There is no need to set class, subnet mask, net, subnet, or node numbers; the server does it for you. The Macintosh computer that uses this configuration is assigned an address every time it starts up, as long as you have a properly configured server.

After you restart, the class, subnet mask, net, subnet, and node numbers assigned by the server are reflected in the Administrator dialog box and in the IP Address box. The user does not have to set any address information.

Setting the node number dynamically

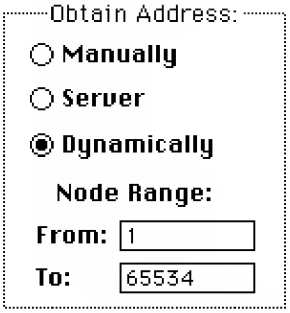
If you select the Dynamically button in the Obtain Address box, the node portion of the IP address is allocated dynamically within the range of node numbers specified.

An IP address has a range of valid node numbers that are determined by the IP address class and subnet mask. With dynamic addressing, the MacTCP software randomly selects a node address in that range and, using ARP, broadcasts to other nodes on the network, "Is there anyone out there using this address?" If there is no response, that node number is used; if there is a response, the software rebroadcasts until it finds a number that is not being used by other machines on the network.

To use dynamic addressing, set the IP address class, subnet mask, and net and subnet numbers as described in the earlier section "Setting the Address Manually." Click the Dynamically button in the Obtain Address box. Two boxes appear showing the range of valid node numbers determined by the class and subnet mask. After you save changes made to the Administrator dialog box, a node number is assigned dynamically when you start the Macintosh computer.

This choice causes the IP Address box to appear on the MacTCP control panel with the address already set. The user does not have to set any address information.

If you know there are static addresses on your network, you can change the values in the Node Range boxes so that the addresses in the static range are not used. To change the minimum range value, double-click the From box, as shown in the following figure, and type an appropriate number. To change the maximum range value, double-click the To box and type an appropriate number.

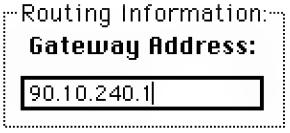


Setting the gateway address

Some gateways use the Routing Information Protocol (RIP) to exchange network routing information. The MacTCP software automatically monitors RIP traffic to determine active gateways. If your network does not use RIP, you must manually set the address of a gateway.

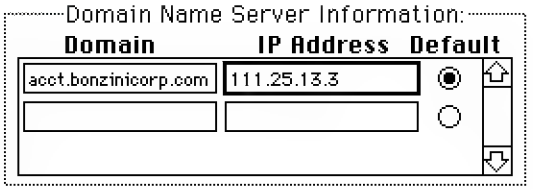
◆ **Note** The default gateway address can also be configured from a server using the BootP protocol. When using AppleTalk (as shown in network configurations 1 and 4) the gateway address need not be specified. ◆

To set the gateway address manually, go to the Routing Information section of the Administrator dialog box. Click the pointer in the Gateway Address box and type the decimal IP address of your gateway, as shown here:



Setting domain name server information

The Domain Name Server Information box allows you to set the IP address of domain name servers and the domains over which they have authority. The box allows you to set this information for your network's domain name server and other domain name servers on the internet.



Click the pointer in the Domain box and specify a domain name. Press the Tab key to move the cursor to the IP Address box and type the address of that domain. As you type the IP address, boxes appear to allow you to enter more domain name server information.

Click the default button to indicate your default domain name server and your default domain name extension. Generally, it should be a domain name server that has authority over your domain.

Domain Name Resolver (DNR) operation

This section describes how the domain name server list is used when making domain name server queries.

If a default name extension and server are identified in the control panel, they are used for all nonqualified requests. For example, if the name `homer` is passed to the Domain Name Resolver (DNR) and the default extension is `pundit.edu`, the name `homer.pundit.edu` is used in the query; however, if the name `homer.drama.pundit.edu` is passed to the DNR, the extension is not appended.

The extension of the name passed to the DNR determines which name servers are chosen. Servers that match the full extension are found first, followed by servers that serve the ancestor of the full extension. For example, for the name `homer.drama.pundit.edu`, the server that servers `drama.pundit.edu` would be found first followed by the server that serves `pundit.edu`. If no servers are found, the default server is used. If you did not set a default, the DNR returns `noNameServer`. In the Administrator dialog box you should type a default domain name and select the Default button.

Once a list of servers that support the domain is found, those servers are queried in the order of their distance from the querying host. First servers on the local network are queried, followed by servers on other networks.

Protecting the configuration

To protect your configuration, click the Protected checkbox (shown in the following figure). If you don't select the Protected checkbox, the user who receives the configured user disk can modify any of the fields in the Administrator dialog box.

Giving the user full configuration power

Recall scenario F in the section "Configuration Scenarios" earlier in this chapter. This scenario allows you to configure the MacTCP driver so that the user can make changes through the Administrator dialog box, giving him or her full configuration power. To accomplish this, distribute an unprotected MacTCP file to the user, as described in Chapter 6.

Since the Protected checkbox has not been selected (see the previous section, "Protecting the Configuration"), the user can access the Administrator dialog box and use it to configure the MacTCP driver. In the other configuration scenarios, you select the Protected checkbox so that the user cannot make changes through the Administrator dialog box.

Closing the control panel

When you have finished typing the appropriate information in the Administrator dialog box, the MacTCP driver is configured. The configuration settings are stored in the MacTCP driver and also in the MacTCP Prep file.

Click the OK button in the Administrator dialog box and then click the Close box to close the control panel window. The configuration changes take effect the next time the driver is used. If the configuration changes cannot be made immediately, the following alert message is displayed.

This message alerts you that you must restart your Macintosh computer for the configuration changes to take effect. When you click the OK button, the control panel closes. When you restart, the MacTCP driver is configured on your computer.

What to do next

You have now configured the MacTCP driver for at least one of your network users. The configuration settings are stored in the MacTCP driver and also in a file called MacTCP Prep. Click the Close box to close the Control Panel window.

- If you plan to manage your network using MacSNMP, turn now to the *MacSNMP Administrator's Guide,* Chapter 2, "Setting Up MacSNMP." When you have finished that chapter, return to this guide and proceed to Chapter 6, "Distributing the TCP/IP Connection Software."
- If you do not plan to implement MacSNMP, proceed to Chapter 6 of this guide, "Distributing the TCP/IP Connection Software."

6 Distributing the TCP/IP Connection Software

This chapter discusses the options and issues you must consider when you distribute the configured TCP/IP Connection software to your users.

△ **Important** If you plan to implement network management using the MacSNMP component of the TCP/IP Connection product, you must configure MacSNMP before you distribute the TCP/IP Connection software. Refer to the *MacSNMP Administrator's Guide,* Chapter 2, "Setting Up MacSNMP." Then return to this chapter for information about distributing the configured software. △

Before you distribute the software

The following sections provide important details that you should understand before you distribute the MacTCP Prep and MacSNMP Client files, and the user documentation.

The MacTCP Prep configuration rules

The following list of rules regarding the MacTCP Prep configuration file is offered to help the administrator avoid problems when the software is distributed.

- A MacTCP Prep file is automatically created when changes are made to the MacTCP configuration settings. (In system software version 6.0.*x*, the MacTCP Prep file is stored in the System Folder; in version 7.*x*, the MacTCP Prep file is stored in the Preferences folder.) If no changes are made, a MacTCP Prep file is not created.
- The MacTCP driver stores all configuration information within the driver itself, as well as in the MacTCP Prep file.
- If a MacTCP Prep file is present, the MacTCP software always reads it first and takes its configuration information from there.
- If you update a computer to a newer version of the MacTCP driver and a MacTCP Prep file already exists, the existing configuration settings are retained when the new MacTCP driver is installed.
- If you want to update a user's computer with a MacTCP driver that you have preconfigured, instruct the user to throw away the MacTCP Prep file, if one exists, before installing the new MacTCP driver.

Giving the MacSNMP Client application to the user

The MacSNMP Client software allows the user to perform several MacSNMP tasks. The user will be able to specify a telephone number and the location of the computer, send a message to the administrator, and import new or modified communities. In addition, the user will be able to view the console access privileges to the Macintosh computer and display the values of variables being managed on the computer.

If you do not want users to perform any of these tasks, you can remove the MacSNMP Client application before distributing the software. If you remove the application, be aware that you will have to specify the location of each computer through your management console using the Set command. In addition you will not be able to use the import feature of MacSNMP to add new communities or to replace communities on a user's Macintosh. Instead, you will have to reinstall the new or modified communities on each computer.

User documentation

Depending on the needs of your users, you can distribute either of two user documents.

The *TCP/IP Connection User's Guide* that is included in your MacTCP Administration package provides detailed user instructions for installing and configuring the TCP/IP Connection software, using the MacSNMP Client application, editing a Hosts file, and using MacTCP Ping. This document is appropriate for users who will either partially or fully configure the MacTCP driver, or who will use any of the other software previously mentioned.

The *TCP/IP Connection* disk contains an optional document named *User Instructions.* This short TeachText file contains excerpts from the *TCP/IP Connection User's Guide.* It instructs the user how to install the MacTCP driver that the network administrator has preconfigured. The file also shows the user how to use the MacTCP control panel to indicate link level information for a specific computer. (These are the minimum tasks that must be performed on each user's computer.) You might choose to distribute this file instead of the *TCP/IP Connection User's Guide* if you plan to configure MacTCP for the users and if the users need no other instructions. You can edit this file as needed to provide site-specific information.

Distribution media

After you have configured the TCP/IP Connection software, you need to distribute it to your users, who will then install (and possibly further configure) the software for their individual workstations.

You can distribute the software in various ways. If your users are already established on a network, you may want to distribute the software over the network. Or, you could

distribute the configured software on distribution disks. Another option is for you to install the software on each machine. Whichever method you choose, you should be aware of some basic rules and hints. The following sections describe these distribution options.

△ **Important** Be aware that you must adhere to the limits of your licensing agreement when placing the TCP/IP Connection software on a file server. Make sure that your agreement covers the number of users who will copy the software from the server. Take reasonable precautions to ensure that the software is not widely available to everyone who has access to the server. For example, deny guest access to the TCP/IP Connection software on the server. △

Distributing MacTCP only—any media

If you plan to distribute only the MacTCP component of the connection software, you can distribute the following software over any distribution media. Simply distribute the appropriate software on a disk or over the network and instruct users how to obtain the files.

- the Network Software Installer (NSI) program, version 1.3 or later
- the MacTCP file that you configured (located in your Control Panel), or the unconfigured file from the *TCP/IP Connection* disk
- the Installer file and the TCP/IP Connection Script file from the *TCP/IP Connection* disk
- the MacTCP Token Ring Extension software, for computers on a Token Ring network
- MacTCP Ping, if you intend for users to use this fault isolation test tool
- the Hosts file, if used
- either the *TCP/IP Connection User's Guide* or the User Instructions file from the *TCP/IP Connection* disk

Distributing a MacTCP startup disk—version 6.0.*x* only

To create a MacTCP startup disk for users who are running system software version 6.0.*x*, perform the following steps:

△ **Important** It is recommended that you use a high-density disk. If your computer does not have a high-density disk drive, perform a customized system software installation to install the minimum system software for your specific computer. △

1. Create a startup disk.

   Install version 6.0.*x* on a blank disk. (The disk may have to be initialized.)

2. Drag the Hosts file from your System Folder into the System Folder on the startup disk.

3. Drag the MacTCP Ping file onto the startup disk.

4. Drag the MacTCP file from your System Folder into the System Folder on the startup disk.

5. If the user is on a Token Ring network, drag the MacTCP Token Ring Extension file into the System Folder on the startup disk. (This step requires that you have a high-density disk.)

6. Distribute the MacTCP startup disk, the NSI disk, and either the User Instructions file or the *TCP/IP Connection User's Guide.*

Distributing the TCP/IP Connection software on floppy disks

This section describes how to create distribution disks for the network users. You can also use the disk you create to perform the installation for users.

1 Make a copy of the *TCP/IP Connection* and *NSI* disks and put the masters away in a safe place.

2 Insert the copy of the *TCP/IP Connection* disk into a disk drive on your computer.

3 Drag the SNMP Preferences file from your Preferences folder (located within your System Folder) onto the *TCP/IP Connection* disk.

A dialog box appears, asking whether you want to replace the existing SNMP Preferences file on the floppy disk. Click the Replace button.

4 If you do not want users to have the MacSNMP Client application, remove it from the *TCP/IP Connection* disk.

5 If you have configured MacTCP for your users, drag the MacTCP file from your Control Panel folder (located within your System Folder) into the MacTCP Software folder on the *TCP/IP Connection* disk.

A dialog box appears, asking whether you want to replace the existing MacTCP file on the floppy disk. Click the Replace button.

6 Write-protect the *TCP/IP Connection* disk, label it, and distribute it to users (or use the disk yourself to install the software for your users).

Distribute the *TCP/IP Connection* disk, the *NSI* disk, and either the User Instructions file or the *TCP/IP Connection User's Guide*.

Distributing the TCP/IP Connection software over the network

An easy way to distribute the TCP/IP Connection software is by placing it on an AppleShare file server so that users can install the software over the network. Alternatively, you can use the Macintosh file-sharing feature built into system software version 7.*x* to allow users to copy the software from your own computer.

Follow these steps to place the software on an AppleShare file server or shared disk:

1. Make a copy of the *TCP/IP Connection* and *NSI* disks and put the masters away in a safe place.

2. Insert the copy of the *TCP/IP Connection* disk into a disk drive on your computer.

3. Drag the *TCP/IP Connection* disk icon from your computer to the file server or shared disk.

   A TCP/IP Connection folder is created on the server or shared disk. Note that the name of the folder must be TCP/IP Connection for the TCP/IP Connection Script to recognize the folder.

4. Insert the copy of the *NSI* disk into a disk drive on your computer.

5. Drag the *Network Software Installer* disk icon (included in your Connection package) from your computer to the file server or shared disk.

   A Network Software Installer folder is created on the server or shared disk.

6. Open the Preferences folder on your computer (located in your System Folder) and drag the SNMP Preferences file onto the new TCP/IP Connection folder on the file server or shared disk.

   A dialog box appears, asking whether you want to replace the existing SNMP Preferences file. Click the Replace button.

7. If you do not want users to have the MacSNMP Client application, remove it from the Connection folder.

8 If you have configured MacTCP for your users, drag the MacTCP file from your Control Panel folder (located within your System Folder) into the MacTCP Software folder in the new TCP/IP Connection folder, located on the file server or shared disk.

A dialog box appears, asking whether you want to replace the existing MacTCP file. Click the Replace button.

9 Notify your users how to access the TCP/IP Connection folder and the NSI folder.

10 Distribute either the User Instructions file or the *TCP/IP Connection User's Guide.*

Part 3 Appendixes

Appendix A: Name-to-Address Mapping

The TCP/IP Connection software includes a Hosts file that maps machine names to internet addresses, the same service provided by the domain name system. You can use the Hosts file if there is no domain name server on your network. It is also convenient to place frequently used name-to-address mappings in this file.

To use the Hosts file, you must edit the sample file that is included with the TCP/IP Connection software and add text that defines name-to-address mappings. Each host on your network that uses Hosts file services must have the file resident on the disk.

This appendix describes the syntax of the Hosts file and how to edit it.

Hosts file syntax

The Hosts file syntax conforms to the master file syntax specified in Request for Comment (RFC) 1035. Refer to this RFC for more information.

◆ **Note** $INCLUDE has not been implemented. ◆

The syntax of the Hosts file is as follows:

```
<name>    <type>    <data>       [;<comment>]
```

- `name` is the name assigned to a host or domain on the internet.
- `type` is A (address), NS (name server), or CNAME (canonical name).
- `data` is determined by the type specified:
  - If `type` = `A`, the data field contains an internet address.
  - If `type` = `NS`, the data field contains the name of the domain name server that has authority over the domain specified in the name field.
  - If `type` = `CNAME`, the data field contains the canonical (or official) name for the name field.
- `comment` allows you to add a comment to the entry. A semicolon is used to start a comment.

Any combination of tabs and spaces can be used as a delimiter between each item in a line. Lines end with the return and line feed characters. Example entries in a Hosts file are as follows:

```
acct.xco.com A     128.8.1.1       ; address of host "acct"
xco.com      NS    server.xco.com  ; name server for domain xco.com
fred.xco.com CNAME bonzini.xco.com ; canonical name for alias fred.xco.com
```

Editing the Hosts file

MacTCP software includes a sample Hosts file and the TeachText editor. To create Hosts files for network users, modify the sample file using TeachText, adding text that defines name-to-address mappings for your particular network configuration.

To edit the Hosts file, perform the following steps:

1. **Select the sample Hosts file icon titled *Hosts* included with your MacTCP software, and open it by choosing Open from the File menu or by double-clicking the icon.**

2. **Add names and internet addresses in the syntax specified in the previous section.**

   You can edit the Hosts file with any word processor as long as you save it as Text Only without formatting commands.

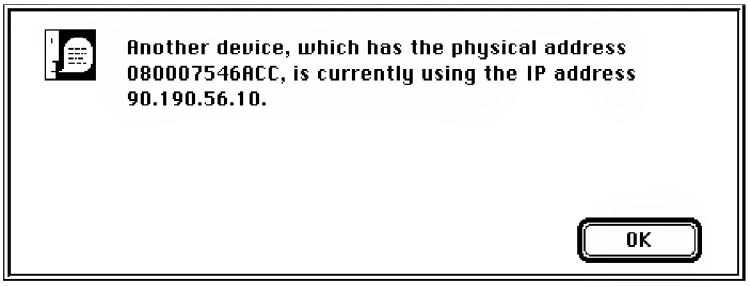
△ **Important** TCP/IP protocols do not allow the use of international and graphics characters. Some word processors and editors do allow these characters; however, using them can cause unpredictable results. △

Appendix B: Troubleshooting

Because an internet is a large and complex aggregate of network hardware connected by gateways, tracking a single-point hardware or software failure can often be difficult. This appendix describes two troubleshooting features—a duplicate address notification dialog box and a fault-isolation tool, MacTCP Ping, which collects and computes packet-transmission statistics.

Duplicate address notification

The TCP/IP Connection software includes a duplicate address notification feature. If there is a duplication problem, the software displays a dialog box informing you that your system is attempting to use the address of another system or that that system is using your address. The dialog box shows the hardware address of the system that is advertising its use of the particular IP address. This address should be recorded for diagnostic purposes so that a network administrator can correct the problem.



◆ **Note** This dialog box may also appear if MacTCP is configured such that the user's computer is not on the same network as the router. ◆

MacTCP Ping

MacTCP Ping is a network testing tool that uses the Internet Control Message Protocol (ICMP) echo request datagram to elicit an ICMP echo reply from a host or gateway. It is intended for use in network testing, measurement, and management, and should be used primarily for manual fault isolation.

When used for fault isolation, MacTCP Ping should first be run on the local host to verify that the local network interface is up and running. After the local network is verified, hosts and gateways successively farther away should be pinged. MacTCP Ping computes round-trip times and packet-loss statistics. MacTCP Ping can also send IP options along with ICMP echo request packets. This release of MacTCP Ping supports the Record Route option.

When you open MacTCP Ping, the MacTCP Ping information dialog box is displayed. The following sections describe the MacTCP Ping user interface: its menus and the MacTCP Ping information dialog box.

MacTCP Ping menus

MacTCP Ping provides three menus, File, Edit, and Options, that are discussed in the following sections.

File

The File menu contains the commands Save As and Quit. Save As allows the user to save the session information into a TeachText file. Quit causes MacTCP Ping to stop sending ICMP echo request datagrams to the host (if necessary) and quits MacTCP Ping.

Edit

The Edit menu contains the command Delete Data, which clears the session information from the display window.

Options

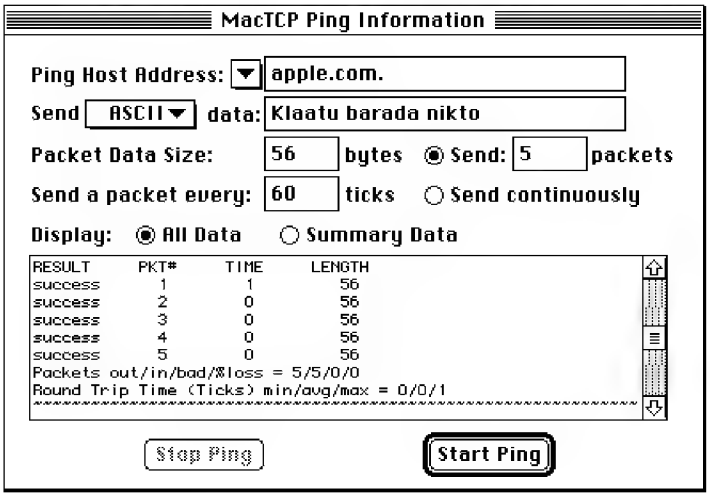
The Options menu contains two commands, Record Route and Show IP Address.

The Record Route command causes MacTCP to send the Record Route IP option along with the ICMP echo packet. The Record Route option provides a means to record the route of an internet datagram. When an internet module routes a datagram, it checks to see if the Record Route option is present. If it is, the module inserts its own internet address into the Record Route buffer of the datagram. When a destination host receives this echo request, it copies its Record Route buffer into the echo response and sends it back to the source host. When the source host receives an echo response, the Record Route buffer contains the round trip path of the datagram. MacTCP Ping shows the round trip path of only the last datagram transmitted.

The Show IP Address command displays the IP address of the local host Macintosh computer in the information window.

MacTCP Ping Information dialog box

The following paragraphs describe features of the MacTCP Ping Information dialog box.



Ping Host Address

The pop-up menu shows a list of host names from the MacTCP Hosts file from which you can choose. The user can also type the host name or IP address of the destination host to be pinged.

Send ASCII/Hex Data

The user can send either ASCII or hexidecimal data along with an ICMP echo request datagram. The ASCII/Hex pop-up menu lets the user choose between these two commands. Hexidecimal data should be entered as a hex string (0–9, A–F, and a–f). The Hex Data command is useful for diagnosing data-dependent problems in a network.

Packet Data Size

Packet Data Size specifies the number of data bytes to be sent. The default is 56, which becomes 64 ICMP data bytes when combined with the 8 bytes of ICMP header data. MacTCP Ping allows the user to send up to 5000 bytes in one ICMP echo request packet.

Send a packet every # ticks

MacTCP Ping waits a given number of ticks between sending each packet. (One tick is 1/60 second or approximately 17 milliseconds.) The default is 60 ticks (that is, 1 second). The minimum value allowed is 1 tick (17 milliseconds). This value should be used carefully, since it can flood the network with ICMP datagrams. "Flood pinging" is not recommended in general, and flood pinging the broadcast address should only be done under very controlled conditions.

MacTCP Ping can send either a fixed number of echo requests or it can send requests continuously until the user clicks the Stop Ping button.

Display

The user can choose from two features to display the ICMP session information. The All Data option shows the status information of every ICMP echo request packet. The Summary Data option shows only the summary information about the ICMP session.

Start Ping

When the Start Ping button is clicked, MacTCP Ping starts sending ICMP echo request datagrams to the host.

Stop Ping

When the Stop Ping button is clicked, MacTCP Ping stops sending ICMP echo request datagrams to the host.

Information and statistics area

ICMP packet statistics along with the source and destination host addresses are displayed in the bottom rectangular area. The Display–All Data option displays the packet number, round-trip time, and data length. The Display–Summary Data option displays only the average round-trip time and percentage packet-loss statistics. If the Record Route command has been selected, the route of the last packet is displayed in this area.

Glossary

Address Resolution Protocol (ARP) A protocol in the TCP/IP protocol suite that maps internet addresses to physical hardware addresses.

AppleTalk network system The system of network software and hardware used in various implementations of Apple's communications network.

ARPANET A wide area network that served as a basis for networking research and provided a central backbone during development of the Internet. See also *Defense Advanced Research Projects Agency Internet.*

Bootstrap Protocol A protocol in the TCP/IP protocol suite that allows a host to find its internet address and other useful configuration information.

broadcast A network transmission technique in which data is sent to all attached hosts.

datagram A packet of data passed across an internet. The Internet Protocol (IP) attaches a header to data received from the Transmission Control Protocol (TCP) to make an IP datagram. See also *segment.*

Datagram Delivery Protocol-Internet Protocol (DDP-IP) gateway A gateway that connects AppleTalk networks to TCP/IP networks. This gateway takes a TCP/IP packet that is encapsulated in AppleTalk's Datagram Delivery Protocol (DDP) and converts it to Ethernet format.

Defense Advanced Research Projects Agency (DARPA) Internet The collection of networks and gateways, including the ARPANET, MILNET, and NSFnet, that use TCP/IP protocols to communicate. Also called the Internet. See also *ARPANET, internet, MILNET, NSFnet.*

domain name resolver Software used by the domain name system to request information from domain name servers.

domain name server Software used by the domain name system to map domain names to internet addresses.

domain name system An internet service for mapping a name to an internet address.

dotted decimal notation The representation for a 32-bit internet address. Each address is written as four decimal integers separated by periods. See also *internet address.*

Ethernet A high-speed local area network that consists of a cable technology and a series of communication protocols. The hardware (cable) provides the physical link to connect systems.

EtherTalk A high-speed AppleTalk network system that uses the cables of an Ethernet network.

File Transfer Protocol (FTP) A protocol in the TCP/IP protocol suite for transferring files across an internet.

fragmentation The process of breaking an Internet Protocol (IP) datagram into smaller pieces so that it can be transferred over a network that has a small maximum packet size.

frame A group of bits forming a logical transmission unit that is sent between data-link layer entities.

gateway A computer that connects two or more networks and routes packets from one to the other.

hardware address An address used by a physical network. In an Ethernet network, each machine is assigned a 48-bit hardware address.

International Standards Organization (ISO) An international body that specifies network protocol standards. The ISO developed the Open Systems Interconnection (OSI) model. See also *Open Systems Interconnection model.*

internet An interconnected group of networks. When written as Internet, refers to the DARPA Internet.

internet address A 32-bit address assigned to every host that wants to use TCP/IP to communicate across an internet. The address consists of a network and host field. Also called the *IP address.*

Internet Control Message Protocol (ICMP) A protocol in the TCP/IP protocol suite that hosts and gateways on an internet use to inform each other of error conditions.

Internet Protocol (IP) One of the fundamental protocols in the TCP/IP protocol suite, IP is responsible for sending data across multiple networks.

local area network (LAN) A system that connects computers together within restricted geographical areas.

LocalTalk A system of cables, cable extenders, and connector boxes that link computers and peripheral devices in an AppleTalk network system.

MILNET (MILitary NETwork) A wide area network on the DARPA Internet that provides network service to military installations. See also *Defense Advanced Research Projects Agency Internet.*

NSFnet (National Science Foundation NETwork) A wide area network on the DARPA Internet that provides network service to the scientific community. See also *Defense Advanced Research Projects Agency Internet.*

octet Equal to 8 bits. Internet Protocol (IP) addresses consist of 4 octets. The term *octet* is used instead of *byte* because not all hosts use 8-bit bytes.

Open Systems Interconnection (OSI) model A 7-layer reference model developed by the International Standards Organization (ISO) that is used to describe network systems architecture.

packet A unit of data transmitted on a network.

process Programs that communicate; for instance, a file transfer process on one host talks to a file transfer process on another host. A host may be running several processes.

protocol A set of rules that computers must follow to exchange data over a network.

Request for Comments (RFC) A series of technical notes used by the Internet community that contain reports of work, proposals, and protocol specifications.

Reverse Address Resolution Protocol (RARP) A protocol in the TCP/IP protocol suite that maps physical hardware addresses to internet addresses.

route The path that network traffic takes to get from source to destination.

routed software The implementation of the Routing Information Protocol (RIP) for 4.3BSD UNIX.

Routing Information Protocol (RIP) A protocol in the TCP/IP protocol suite that allows gateways and hosts to exchange network routing information.

routing table A table maintained in each internet gateway that contains, for each possible destination network, the next gateway to which data should be sent.

segment A unit of data sent from the Transmission Control Protocol (TCP) on one host to TCP on another. Each segment travels across the internet in an Internet Protocol (IP) datagram. See also *datagram.*

server A program running on a host that offers a service to other hosts on the network. For instance, a file server provides access to its files. Computers that run server programs are often referred to as *servers*. See also *domain name server.*

Simple Mail Transfer Protocol (SMTP) A protocol in the TCP/IP protocol suite that allows electronic mail to be transferred across an internet.

subnetwork address A technique that allows multiple physical networks to share the same internet network address.

subnetwork mask Software used to select bits from an internet address for subnet addressing.

Telnet A protocol in the TCP/IP protocol suite that allows a terminal on one host to appear as if it were directly connected to a remote host on an internet.

Transmission Control Protocol (TCP) One of the fundamental protocols in the TCP/IP protocol suite, TCP provides for the reliable exchange of data between two processes.

User Datagram Protocol (UDP) A protocol in the TCP/IP protocol suite that provides unreliable data transmission between two processes.

wide area network A system for connecting computers over a large geographical area.

Index

A

address class, setting 34, 53–54
addresses, internet
  classes of 16, 34, 53–54
  conventions for 15–23
  and DDP–IP gateway 7
  decimal notation for 16, 50–51, 59
  displaying 81
  of domain name servers 35, 59–60
  and domain name system 4, 19–20
  duplicate 4, 78
  of gateways, setting 34, 59
  integer format for 55–57
  methods for setting 34
  name-to-address mapping 19–20
    73–75
  nodes, setting 34, 57, 58
  notation for 16
  obtaining from server 34, 52, 57
  and physical addresses 21–23
  for routing between networks 12
  and routing tables 26–27
  setting 34, 50–60
  setting dynamically 34, 52, 58
  setting manually 34, 52–57
  static 58
  structure for 16–17, 18
  subnetwork 17–19
Address Resolution Protocol (ARP) 4, 21
  and dynamic addressing 58
  requests and replies using 21
administrator, network
  and configuration authority 32
  protecting and unprotecting
    configuration 32, 34, 35, 61
Administrator dialog box 33–35, 51–52
  accessing 33, 51
  Obtain Address box in 34, 57, 58
  opening 51
  protecting fields in 35
agent software for SNMP 14
AppleTalk network
  configuring, using Ethernet cable
    42–44, 46–47
  configuring, using EtherTalk cable
    44–45
  configuring, using LocalTalk cable
    7, 41
  and gateways 5, 59
  protocols co-resident with MacTCP
    driver 6
architecture, comparison of OSI and
    TCP/IP 11
ARPA, domain name 20
ARPANET 9
ASCII/Hex menu 80

B

Bootstrap Protocol (BOOTP) 4, 23, 59
Buttons
  Dynamically 34, 52, 58
  Manually 34, 52–53
  More (control panel) 33, 51
  Server 34, 52, 57
  Start Ping 81
  Stop Ping 81

C

cable. *See* Ethernet cable; EtherTalk
    cable; LocalTalk cable
cards, networking 5
classes, address 16, 34, 53–54
COM, domain name 20
communication problems, reporting 28
configurations of MacTCP networks 6,
    41–47
  protecting and unprotecting 32, 34,
    35, 61
  storing settings for 64
  for subnets 17–18
configuring MacTCP driver 31–62
  with Administrator dialog box 32–35,
    51–62
  for AppleTalk networks 41–45
  with gateways 41, 44–45
  with MacTCP control panel 32–33

configuring MacTCP driver *(continued)*
and MacTCP Prep 32, 62, 64
setting the IP address 34, 50–50
setting link level information 40–50
strategies for 35–37, 41–48
for Token Ring networks 46–50
tools for 32–35
by users 32, 35–37, 55, 61
console, for SNMP 5, 14
control panel, MacTCP x, 32–33, 39
closing 62
opening 38–39
and setting IP address 50–51
in version 6.0.*x* 39
in version 7.*x* 38

D

DARPA Internet, and network addresses 16
data
ASCII or hexadecimal 80
displaying 81
reliability of 12, 13
Datagram Delivery Protocol–Internet Protocol (DDP–IP) gateway 5, 6, 7, 34, 41, 45
datagram packets
routing of 12, 79
size of 80
timing of 81
undeliverable 28
decimal notation, for IP address 16, 50–51, 59
Defense Advanced Research Projects Agency (DARPA) 9
Delete Data command 79
displaying ICMP information 81
distributing software 63–70
on disks 65–68
and licensing agreement 66
over the network 69–70
documentation, user 65
Domain Name Resolver (DNR) 4, 20, 60
Domain Name Server Information box 35, 59
domain name servers, setting addresses for 35, 59–60
domain name system 19–20, 35, 60
top-level domains in 20
and UDP 13
driver, MacTCP. *See* MacTCP driver
duplicate address notification 4, 78
dynamic addressing 34, 58

E

Edit menu (MacTCP Ping) 79
editing the Hosts file 65, 75
EDU, domain name 20
electronic mail and SMTP 14
Ethernet cable, configuring with 42–44, 46–47
Ethernet card, hardware address 40
Ethernet NB Card 5
Ethernet networks 5, 6, 34, 46–48
EtherTalk cable, configuring with 44–45
EtherTalk NB Card 5

F

fields
in Administrator dialog box, protecting 35
host 16
network 16
File menu (MacTCP Ping) 79
files
Hosts 65, 66, 67, 73–75
Installer 66
MacSNMP Client 68, 69
MacTCP 32, 66
MacTCP Admin 32–35
MacTCP Ping 66, 67, 78–81
MacTCP Prep 32, 62, 64
MacTCP Token Ring Extension 48, 66, 67
MacTCP Token Ring MTU Tool 48
TCP/IP Connection Script 66
transfer of, on internets 13
User Instructions 66
file servers. *See* servers
File Transfer Protocol (FTP) 4, 11, 13
flood pinging 81
floppy disks, distributing on 65–68
flow control, and TCP 12

G

Gateway Address box 59
gateways 26
configuring with 41, 44–45
DDP–IP 5, 6, 7, 34, 41, 45
and ICMP 28
and RIP 27
routing tables for 26–27
setting addresses for 34, 59
GOV, domain name 20

H

hardware requirements 5
header, for IP datagram 12
hexadecimal data, sending 80
host field 16
Hosts file 73–75
distributing 66, 67
editing 65, 75
syntax for 74

I, J, K

icons
in Control Panels window 38
Ethernet 40, 43, 44, 45, 47
EtherTalk 43, 44, 45, 47
LocalTalk 41
MacTCP Token Ring MTU Tool 49
Token Ring 47
Installer file, distributing 66
installing
MacTCP software 31–32
TCP/IP Connection software 65
integer format for IP addresses 55–57

interface, .TOKN 5
International Standards Organization (ISO) 11
and domain names 20
internet addresses. *See* addresses, internet
Internet Control Message Protocol (ICMP) 4, 28, 78, 81
Internet Protocol (IP) 4, 10, 12, 28
and delivery of datagrams 12
and ICMP 28
Internet Request for Comments (RFC) *See* Request for Comments (RFC)
internets. *See also* addresses, internet
defined 9
electronic mail on 14
example of 10
file transfer on 13
remote access on 13
IP address box 34
IP addresses. *See* addresses, internet

L

labels in domain names 19
LaserWriter printers 6
licensing agreement and distribution 66
link level information, setting 40–50
local area networks (LANs)
locating gateways on, with RIP 27
multiple 12, 17–18
subnetwork addressing on 17–19
LocalTalk cable, configuring with 7, 41
LocalTalk networks 5, 6, 41

M

machine names, mapping to addresses 19–20, 73–75
Macintosh computers
physical slots and NuBus slot numbers in 48
requirements for 5
updating with new driver 64
MacSNMP 11, 14, 63, 64–65, 68, 69
MacTCP Admin file 32–35
MacTCP control panel. *See* control panel
MacTCP driver 3–7
books on xi
configuring 31–62
control panel for 32–33, 38–39, 62
co-resident with AppleTalk 6
distributing 66–67
installing 31–32
preconfigured 64
protocols used by 4
software 4–5
and storing configuration information 64
MacTCP Ping
Information dialog box 80–81
menus 79
using 66, 67, 78–81
MacTCP Prep configuration file 32, 62, 64
MacTCP starter disk, creating 67
MacTCP Token Ring Extension software 48, 66, 67
MacTCP Token Ring MTU Tool 48–49
mail, electronic 14
manual addressing 34, 52–57
mapping internet addresses 4, 21, 22, 23
name-to-address 73–75
masks, subnetwork 19
setting 34, 55
Maximum Transmission Units (MTUs) 48–50
memory requirements, RAM 5
MIL, domain name 20
Military Network (MILNET) 9
Military Standards (MIL–STD) xii, 4
More button on control panel 33, 51
MTU size, adjusting 48–50
multivendor networks and SNMP 14

N

name-to-address mapping 19–20, 73–75
naming internet addresses 19–20
National Science Foundation (NSFnet) 9
NET, domain name 20
net numbers
setting 34, 56
sharing 17
network addresses. *See* addresses, internet
network administrator
and configuration authority 32
protecting and unprotecting configuration 34, 35, 61
network field 16
Network Information Center (NIC) 16
and domain name system 19
networks
AppleTalk 5, 6, 7, 41–47, 59
distributing software on 69–70
Ethernet 5, 6, 34, 46–48
LocalTalk 5, 6, 41
multiple 12, 17–18
multivendor, and SNMP 14
routing between 12
Token Ring 5, 6, 46–50
Network Software Installer (NSI) program 66, 68, 69
node numbers
setting manually 34, 57
setting dynamically 34, 58
Node Range boxes 58
NuBus expansion slot architecture 5, 48
and Token Ring control panel 47–48

O

Obtain Address box 34, 57, 58
Open Systems Interconnection (OSI) Reference Model 11
Options menu (MacTCP Ping) 79
ORG, domain name 20

P

packets, datagram
routing of 12, 79
size of 80
timing of 81
undeliverable 28

Ping. *See* MacTCP Ping
Ping Host Address menu 80
Preferences folder
and MacTCP Prep 64
and SNMP Preferences 68, 69
printers, LaserWriter 6
protecting configurations 32, 34, 35, 61
protocols 4, 9–14, 27–28
Address Resolution Protocol (ARP) 4, 21, 58
AppleTalk 6
Bootstrap Protocol (BootP) 4, 23, 59
File Transfer Protocol (FTP) 4, 11, 13
Internet Control Message Protocol (ICMP) 4, 28, 78, 81
Internet Protocol (IP) 4, 10, 12, 28
MacSNMP 11, 14
Reverse Address Resolution Protocol (RARP) 4, 22
routing 27–28
Routing Information Protocol (RIP) 4, 27, 34, 59
Simple Mail Transfer Protocol (SMTP) 11, 14
Simple Network Management Protocol (SNMP) 4, 5, 11, 14, 63, 68
Telnet 4, 11, 12, 13
Transmission Control Protocol 4, 10, 12
User Datagram Protocol (UDP) 4, 11, 13

Q

quitting MacTCP Ping 79

R

RAM requirements 5
Record Route option 78, 79
remote access with Telnet 13
reporting communication problems 28
Request for Comments (RFC) xii, 4
RFC 1034 4
RFC 1035 4, 74
Reverse Address Resolution Protocol (RARP) 4, 22
routing 25–28
between networks 12
of datagrams 12, 79
defined 25
protocols 27–28
tables 26–27
Routing Information box 34–35
Routing Information Protocol (RIP) 4, 27, 34, 59

S

Save As command 79
Server button 34, 52, 57
servers
configuring gateway addresses from 59
and licensing agreement 66
obtaining address from 34, 57
required on Ethernet 34
Show IP Address command 79
Simple Mail Transfer Protocol (SMTP) 11, 14
Simple Network Management Protocol (SNMP) 4, 5, 11, 14, 63, 68
software. *See also* MacTCP driver
distributing 63–70
EtherTalk 5
MacSNMP Client 64–65
MacTCP, distributing 63–70
MacTCP, installing 31–32
MacTCP Token Ring Extension 48, 66, 67
Network Software Installer (NSI) 66, 68, 69
requirements 5
TCP/IP Connection 65, 66, 68, 69, 73, 78
TokenTalk 5
Start Ping button 81
startup disk, creating 67
static addresses 58
statistics, ICMP packet 81
Stop Ping button 81
subnet masks 19, 34, 55
subnet number, setting 34, 57
subnetworks
addresses on 17–19
configuration of 17–18
and masks 19
syntax for Hosts file 74
System Folder, and MacTCP Prep 64
system requirements 5
system software versions 6.0.*x* and 7.*x* x, 5

T

TCP/IP 9–14
compared to OSI 11
distributing software for 63–70
TCP/IP Administration disk 48
TCP/IP Connection disk 65, 68, 69, 73, 78
TCP/IP Connection Script file, distributing 66
Telnet 4, 11, 12, 13
Token Ring networks 5, 6
configuring for 46–50
TokenTalk NB Card 5, 47
.TOKN interface 5
Transmission Control Protocol (TCP) 4, 10, 12
and delivery of datagrams 12
troubleshooting 77–81

U

UNIX, 4.3BSD 27
updating computers with new driver 64
User Datagram Protocol (UDP) 4, 11, 13
user documentation 65
users
configuration by 32, 35–37, 55, 61
and MacSNMP Client application 64–65

V

variables, and SNMP 14

W, X, Y

Windows
Control Panel (version 6.0.*x*) 39
Control Panels (version 7.*x*) 38
MacTCP control panel 47

Z

zone pop-up menu 41–42

The Apple Publishing System

The *MacTCP Administration Guide* was written, edited, and composed on a desktop publishing system using Apple Macintosh computers, Microsoft Word, and QuarkXPress. Proof pages were printed on Apple LaserWriter printers. Line art was created with Adobe Illustrator. Final pages were output directly to 70-mm film on an Electrocomp 2000 Electron Beam Recorder. PostScript™, the LaserWriter page-description language, was developed by Adobe Systems Incorporated.

Text and display type are Apple's corporate font, a condensed version of Garamond. Bullets are ITC Zapf Dingbats®. Some elements, such as program listings, are set in Apple Courier, a fixed-width font.